MANAGEMENT HANDBOOK

To Aid Emergency Expansion of

Dehydration Facilities for Vegetables and Fruits

VOLUME II

SWEETPOTATO SUPPLEMENT

A Phase II Preparedness Study

Prepared at the Request of
Office of the Quartermaster General
Department of the Army
Washington, D. C.

By

Western Regional Research Laboratory
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
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CHAPTER I

BASIC ASSUMPTIONS

Foreword

The planning of a dehydration plant meeting national emergency needs should take full cognizance of the information and suggestions given in Volume I of this Handbook. This set of plans for a sweetpotato dehydration plant is based upon the principles set forth in that portion of the Handbook.

Product Desired

The plant covered by this section of the Handbook is designed to produce dehydrated sweetpotato dice (Type II) in accordance with the Military Specifications "Potatoes, Sweet, Dehydrated" (MIL-P-3025) dated 26 February 1945 plus Amendment-1 dated 30 November 1949.

Bases For Operations, Facilities, and Cost Estimates

A. Location of Plant

Most of the sweetpotato dehydration during World War II was done in Louisiana because that was the largest producing area for the varieties best suited for dehydration use. This area is still considered one of the best sourcesof suitable sweetpotatoes for dehydration. These estimates are based on a plant (1) located in south-central Louisiana and (2) operating during the fall and winter months. The general plan, design, and operations are applicable, however, to plants located in other areas.

B. Operating Basis

Design and cost estimates are based upon an operation of three 8-hour shifts per day, six days a week, and 150 operating days a year.

Labor costs are based on rates calculated from typical labor rates in Louisiana for unskilled labor adjusted to the bracket classification used in the other dehydration plant plans. These adjusted rates will, in some cases, be higher than those actually paid in the Louisana area, but this procedure puts the various plants in this Handbook on a comparable basis for cost estimation purposes.

The labor rates used in this set of plans are as follows:

Class Labor	Hourly Rate (40-hr.wk. basis)
1	$1.30
2	1.20
3	1.00
4	0.90
5	0.85
6	0.75

C. Raw Commodity Used

It has been assumed that the Porto Rico variety of sweetpotato will be used exclusively in the proposed plant. Inasmuch as curing is recommended for all sweetpotatoes before dehydration, it is assumed that this dehydration plant will commence operation about one month after the start of harvesting. This would allow one month of operation on cured-but-unstored raw commodity and five months of operation on cured-and-stored raw commodity.

Provision has been made in the cost estimates for raw commodity prices ranging from $40 to $100 per ton.

D. Plant Capacity and Yields

This plant has been designed to have a normal processing capacity of 100 tons per day of raw sweetpotatoes. Plant capacity is based on 24 hour per day operation of the dicers, blancher, dehydrators, and bin driers, but only 20 hour per day operation of the rest of the plant.

The over-all shrinkage ratio for this plant is assumed to be 6:1 (plants operating during World War II reported over-all shrinkage ratios from 5:1 to 7:1). On the basis of a 6:1 over-all shrinkage ratio, 100 pounds of raw sweetpotatoes yield 16.6 pounds of dehydrated diced Type II product. In addition, it is assumed that 1.5 pounds of "fines" and 1.0 pound of "defects" will be produced. The "fines" have possible use as pie-stock, etc., and the "defects" are suitable for stockfeed. 1/ Such a disposal of these by-products would result in lowered cost for the dehydrated sweetpotato dice, but are not included in these cost estimates.

E. Storage Space

Storage space in the plant building is provided in this set of plans for handling a raw sweetpotato supply equivalent to 5 to 7 days of plant operation. In addition, space has been provided for holding up to a 30-day production of dehydrated sweetpotato dice plus a 10-day supply of empty cans and cases, or any desired combination of these items.

F. Waste Disposal

It is assumed that the sweetpotato trimmings, about 35 tons per day, will be hauled away by farmers, for cattle feed, at no cost to the plant.

1/ Trimming and peeling wastes also may be suitable for stockfeed

CHAPTER II

SUPPLY OF RAW SWEETPOTATOES

Characteristics Desired in Raw Sweetpotatoes to be Dehydrated

The military specifications (Potatoes, Sweet, Dehydrated, MIL_P-3025, dated 26 February 1945 plus Amendment-1 dated 30 November 1949) require that the fresh sweetpotatoes to be dehydrated shall be clean, sound, mature, deep yellow to pink in color, and of good cooking quality. They shall be of the "moist" or "semimoist" type, but those which discolor or become soggy after cooking shall not be used. Potatoes showing a cream to light yellow over-all color shall be discarded. Sweetpotatoes of U. S. No. 1 or U. S. No. 2 grade (or mixture thereof), conforming with "U. S. Standards for Sweet Potatoes", shall be used. Such sweetpotatoes must meet the following quality standards:

1. Of the same type of flesh, with no material variation in color.
2. Firm -- not soft, flabby, or shriveled
3. Free from soft rot, black rot, and also free from pieces of roots, vines, root crowns, sprouts, dirt, and other foreign matter. Such material shall not be scored against the grade, but rather scored as cull material
4. Free from freezing injury and damage consisting of any injury or defect which materially affects the edible or processing quality, or the removal of which would result in a loss of more than 25% by weight. Such damage may be caused by dry rot, other diseases, bruises, cuts, internal discoloration, growth cracks, pithiness, scale, wireworm, weevil, other insects, stringiness, sunburn, and damage by mechanical or other means.

U. S. No. 1 and U. S. No. 2 grades differ only in that misshapen roots may not be included in No. 1's and that damage in No. 1's is limited to 10% by weight.

Maturity cannot be a definite required characteristic for sweetpotatoes harvested for dehydration use, because, being a true root, sweetpotatoes never reach a definite stage of development called maturity. Maturity can only be a matter of size. Nevertheless, changes take place within the root toward the end of the growing season, just before frost, which increase carotene content and total solids.

The special characteristics desired in sweetpotatoes for dehydration have to do with color and shape. A deep orange, or orange-yellow flesh, is desired, for it is an indication of high carotene content. Fortunately, there are mutations of common varieties that have been developed to give this desired color and carotene content characteristic. Proper storage and curing will tend to enhance the intensity of the yellow color.

A uniform and symmetrical shape is desired for facilitating the preparation for dehydration. Unfortunately, the popular varieties in the chief growing areas, and those varieties with the higher solids content, are commonly very irregular in shape -- oftentimes are very long and crooked. For economy in preparation, the misshapen roots should be culled out, and an effort should be made to obtain the larger sizes.

Table I gives the characteristics of the principal commercial varieties of sweetpotatoes.

Suitable Dehydration Varieties and Commercial Production Data

Sweetpotato varieties are of two groups: the "moist-fleshed" ones (sometimes called "yams") and the "dry-fleshed" ones. Strange to say, the "dry" varieties contain a larger proportion of water than the "moist" varieties. 1/

The principal "moist-fleshed" varieties are the Porto Rico and Nancy Hall. In recent years these have increased in popularity not only in the South but among northern consumers. The Porto Rico is the most widely grown variety because of its high yield, relative freedom from disease, and good storage quality; it is a desirable variety for dehydration also because of its high carotene content.

The "dry-fleshed" or Jersey type of sweetpotato is raised in the more northerly growing districts and is generally favored by northern growers because of its more attractive, uniform, and symmetrical shape. Military specifications do not permit the use of this type for dehydration. The principal "dry" varieties are the Big-Stem Jersey and the Little-Stem Jersey.

The major sweetpotato producing area is along the Gulf and Atlantic Coastal plain from East Texas through New Jersey, with a concentration of production in St. Landry, Lafayette, and Acadia Parishes of Louisiana, The "moist" or Porto Rico variety predominates from Texas through North Carolina, and the "dry" or Jersey variety predominates from Virginia through New Jersey. California is the only western state important in sweetpotato production. (See Table II for production and acreage by states.)

Sweetpotato production in the United States has been generally declining for many years. Production was high throughout the depression period of the early 1930's -- at times 50% more than the current production. Peak production was in the war year 1943. The decline can be attributed to several causes: (1) the relatively large amount of hand labor required in planting, growing, and harvesting operations in comparison with competing crops, (2) the decline in the consumption per capita of starch foods, and (3) the high losses in storage. About 15% to 25% of the crop is annually fed to livestock or lost through spoilage.

The prospective sweetpotato dehydrator should not plan his raw material supply on the basis of the total production. Only the production which is of such quality that it can be sold off the farm for food use, and is properly cured and stored, is an appropriate source of supply for dehydration. Table III shows for the leading States the production of sweetpotatoes which were sold off the farms in 1950, and the percentage of the crop marketed by each State.

While sweetpotatoes are generally available throughout the Southern States, two areas are particularly worthy of consideration for the location of dehydration plants. Growers in Louisiana and the Carolinas have been particularly careful with regard to seed stock selection, production practices, and storing and handling of sweetpotatoes. The concentration of sweetpotato production is probably greater in south-central Louisiana than in any other part of the country.

1/ Boswell, V. R. Commercial Growing and Harvesting of Sweetpotatoes. Washington, D.C., 1950 (U.S. Dept of Agriculture Farmers' Bulletin 2020)

Procurement Problems

A. Supply of Seed

For the country as a whole, most of the sweetpotato crop is started with plants ("slips") sprouted from the seed roots. About 5% of the total crop is used for propagating purposes. New plants are produced by bedding the roots in warm, heated soil or sand, and removing the sprouts that grow from these roots. The seed stock should be carefully selected in the field at harvest time. It is important for a grower to obtain seed stock of dependable characteristics and quality and be free from disease. At least 15 bushels of seed stock should be saved for each acre to be planted the following year.

The new sprouts or "slips" are transplanted to the field in the spring about 4 weeks after the last killing frost, when the daily mean temperature approaches 70° F. In the South many growers use "slips" for only a portion of their total acreage (early plantings) and use vine "cuttings" from the early patches for the remaining later plantings. "Cuttings" are slower in starting than plants which are already rooted and hence give lower yields for a given date of harvest. Where the growing season is long enough, however, this disadvantage is offset, or more than offset, by the reduced costs of seed-bed preparation and maintenance, by the lower quantity of seedstock required, and by the greatly reduced risk of carrying disease infection from the bedded roots into the planted field. "Cuttings" also offer some advantages for machine planting.

B. Soil, Fertilizer, and Other Cultural Requirements

Sweetpotatoes require an average frost-free growing season of five months, extensive hot weather, and an abundance of moisture. The crop should have the equivalent of about one inch of rainfall per week during the growing season. The soil must be well drained. More desirable sizes and shapes of roots are produced on medium to light soils. The soils must be of good fertility, either naturally or by the addition of manures and other fertilizers. Sweetpotatoes require but moderate amounts of soil nitrogen and organic matter in comparison with other truck crops. They can follow successfully any one of a number of other crops in the rotation, but it is essential that cover crops be grown in the cropping system. The remains of preceding crops rarely cause difficulty when plowed or disced into the soil in the fall.

Growers should make efforts to recognize symptoms of a lack of balance of certain plant nutrients which influence quantity and quality of the sweetpotatoes. The processor and growers should consult their State Agricultural Experiment Station and County Agricultural Agents or farm advisors in regard to desirable cultural practices.

In the most important sweetpotato growing districts the sweetpotato is allowed to grow as late in the season as possible, because a substantial share of the yield is developed in the last 4 or 5 weeks before frost. For maximum yields, 130 to 150 days of growth are required. For the large sizes used for dehydration, the yield is often 8 to 10 tons per acre as compared with the state averages of between 2 and 3 tons per acre. Early harvested roots are lower in both carotene content and total solids content than those harvested just before frost. However, if the roots are to be used as a source of sprouts for reproduction, temperatures approaching freezing should be avoided.

C. Harvesting and Transplanting of Sweetpotatoes

Typical planting and harvesting dates for the states that are principal sweetpotato producers are given in Figure 1 and Table IV.

Lack of adequate mechanization of harvesting has contributed to the high labor cost of production and to the decline in production of sweetpotatoes since 1932. The roots must be removed from the soil by human hands with great care to prevent scratches or bruises. Often pickers are required to wear cotton gloves to prevent scratching. After removal from the soil, the sweetpotatoes should be exposed to the air and sun long enough for the surface soil on them to dry so that it will fall off in handling. Then each grade is placed in separate baskets or crates as the roots are picked up from the row. This avoids an extra handling. The labor required in harvesting sweetpotatoes to supply a dehydrator is about three times as much as in harvesting a comparable quantity of white potatoes.

In Louisiana the industry has largely standardized on a single type of container for moving from the field, storing, and shipping. This is the wire-bound, collapsible, veneer-slat, nearly cubical crate holding a net weight of 50 pounds of sweetpotatoes after storage. It was originally known as the "James crate". The style and construction of shipping crates varies in different areas. In some sections, such as the Carolinas, bushel tub baskets are largely used.

Where the sweetpotatoes are purchased and used for processing only, as in canning or dehydration, the crates are owned by the plant and repeatedly reused. Crates of sturdy wood slat construction have definite advantages for handling and storage. Such crates were used for handling seedstock in the starch plant operations at Laurel, Mississippi, and later used for all raw stock handling in the dehydration operations.

D. Curing and Storing Raw Sweetpotatoes

Sweetpotatoes of the variety suitable for dehydration are harvested in Louisiana starting in late July and ending about the middle of November. Consequently, processing of sweetpotatoes after the middle of November is done on the stored commodity. It is necessary that sweetpotatoes be carefully "cured" immediately after they are dug, whether they are to be dehydrated or whether they are to be placed in storage.

Sweetpotatoes are a relatively tender and perishable commodity, and the curing and storage require carefully controlled conditions to minimize spoilage losses in storage. The procedure used which has achieved the greatest success is as follows: Immediately after harvest, without an over-night delay, sweetpotatoes are placed in a room where the temperature is held at 85°F. and the relative humidity is 85% to 90%. After about 8 days of curing under these conditions, the temperature is gradually lowered to 55°F. or 60°F., with the relative humidity at 75% to 85%, and these conditions are maintained throughout the storage period. If sweetpotatoes are to be shipped and stored after the initial curing, then the curing must be repeated.

Even under the best conditions it is common experience for spoilage in storage to amount to 5% to 10%. If the temperature of the sweetpotatoes is allowed to fall below 50°F. in storage or shipping, the losses may be quite high. An exposure of only 4 days at 40°F. will result in considerable discoloration; if the temperature is allowed to stay as low as 40°F. for three weeks or more, over half of the sweetpotatoes can be expected to rot.

There is a need for more good commercial storage facilities for sweetpotatoes; also, there is much room for improvement in the quality of a large portion of the available storage, as evidenced by the 20% to 50% losses incurred in some storage houses.

Although curing and storage of sweetpotatoes were originally intended only to provide sweetpotatoes after the end of the harvest period, other benefits also are gained. Sweetpotatoes which have been harvested before attaining maximum color and

sweetness may be improved in these respects during the curing and storage period. Thus, raw commodity which may have been only of medium quality when harvested is often of excellent quality after curing and 30 to 60 days of storage. Properly cured and stored sweetpotatoes have been found to be still highly acceptable for dehydration purposes after as long as 6 months storage.

Because of these desirable changes which occur in the raw commodity when it is properly cured and stored, in the later years of World War II there was an increasing tendency to dehydrate only the sweetpotatoes which had been cured, or cured-and-stored. It is recommended, therefore, that the dehydrating operations commence after the first of September so that early-dug sweetpotatoes may be cured and stored for a short time prior to processing.

E. Competing Outlets for Raw Sweetpotatoes

The per capita consumption of sweetpotatoes has been declining for many years.2/ The difficulty in mechanization of production and the extreme care necessary in handling and storage has made it difficult for the grower to compete with the growers of other crops satisfying similar food requirements. Less than one-half of the United States sweetpotato production is actually sold. About 30% of the production is used in the household of the farm where grown, and an additional 20% is fed to livestock or lost through shrinkage and rot. Table III shows the quantities of sweetpotatoes actually sold in the principal producing states.

In Louisiana in 1947, 10% of the sweetpotato production was dehydrated for stock feed. 3/ The principal role of sweetpotato dehydration in this major production area since World War II has been as a salvage operation incidental to the commercial production of sweetpotatoes for food. The farmers received only $8 to $10 per ton for this salvaged raw material as compared with the average farmer's price of $60 per ton for sweetpotatoes marketed for food. At present it is not feasible for farmers to grow sweetpotatoes for a stockfeed crop, except possibly with high yielding varieties suited only to stockfeed and with cheaper methods of planting and harvesting than ordinarily used.

F. Competition With Other Crops for Acreage

Sweetpotatoes are grown over a wide area in all southern states on farms of many different types, such as truck farms, dairy farms, cotton farms, tobacco farms, and corn and hog farms. In order to lessen the likelihood of the land being infected with disease-causing organisms, it is better to grow sweetpotatoes on a particular piece of land only one year out of four or five. Sweetpotatoes can follow successfully any one of a wide variety of crops. The crops that will be grown between years of sweetpotato plantings will depend on what other crops are profitably grown in the particular economy of the individual farm. Cotton in particular is often the chief competitor for acreage.

2/ U. S. Bur. of Agric. Economics. Consumption of Food in the United States, 1909-48. Washington, D. C., 1949 (U.S.Dept. of Agriculture Miscellaneous Publication 691); and its supplements for 1949 (published 1950), and 1950 (in the Bureau's National Food Situation NFS-57, July-Sept., 1951)

3/ Miller, M.E., Ford, K.E., and Woodlin, M.D. An Economic Study of the Dehydration of Sweetpotatoes for Feed in Louisiana. Baton Rouge, 1949 (La. Agric. Experiment Station Bulletin 437)

G. Considerations in Obtaining Sweetpotatoes

The procurement of sweetpotatoes for processing presents many problems because of the nature of the farming industry in the chief producing areas. Sweetpotato dehydrators are not now in operation, but the following description of practices applies to present-day sweetpotato canners and to the dehydrators that operated during World War II. Practices in procurement vary with different plant operators; the same operator will vary his procurement practices from season to season. Some operators contract with farmers for at least a part of the amount of sweetpotatoes needed by the plant, and provide their own storage facilities for the sweetpotatoes that are to be processed after the harvest season ends. Other operators purchase from farmers in the open market during the harvest season, and either provide their own storage as needed or contract for storage from others. Still other operators draw their entire raw material supply from commercial packing plants during the harvesting season, and obtain their post-harvest supply from commercial storage operators and shippers.

The difficulty of procuring an adequate supply of raw material directly from farmers is illustrated by conditions in the chief sweetpotato growing parishes of Louisiana where the bulk of the dehydrated product was produced during World War II. A 100-ton per day dehydrator will require 15,000 tons of raw product in a 6-month operating season. This is about 600,000 bushels (50 lbs./bushel). Due to the limitations of farm family man-power and the nature of tenancy in the parishes, the average farm planting of sweetpotatoes is only 20 acres. The average yield in Louisiana is 2.75 tons per acre. Therefore, with only 55 tons per farm, it would require nearly 300 grower-contractors to obtain the 15,000 tons required for a 100-ton dehydrator. If the yield were 8 tons per acre, as may be the case when the sweetpotatoes are grown especially for dehydration, the total requirements for a plant could be grown by approximately 100 growers. In any event, a rather large staff of field men would need to be employed by the dehydration plant to service the number of growers required.

It might be more feasible for the processor to purchase his raw material from one or more shippers of sweetpotatoes, or for the shipper himself to become the processor. The shippers purchase from farmers, and cure and store the product in their warehouses. From time to time, the sweetpotatoes are removed from storage, washed and graded, and the U. S. No. 1 grade shipped for immediate fresh market use. It is always a problem to dispose of the U. S. No. 2 grade which may have smaller diameter and misshapen roots, and may have more than 10% mechanically damaged material. Inasmuch as military specifications permit the use of either U. S. No. 1 or U. S. No. 2 grade of sweetpotatoes for dehydration, No. 2 grade should find a good outlet for meeting dehydration needs provided the price is sufficiently low to offset any extra cost of processing. As the quantities of the No. 2 grade are often large, the fresh market shippers might be found to be as important and reliable a source of raw material as the growers under contract.

TABLE I

Characteristics of Principal Commercial Varieties of Sweetpotatoes

Variety	Mutation or Strain	Average Solids 1/ (%)	Flesh color	Shape	Remarks
Moist or Soft-Fleshed - "Yams"					
Porto Rico	Cliett Bunch Porto Rico Improved Red Double Red Key West Velvet	32	Orange yellow to salmon	Spindle-shaped to globular	The dominant variety in the South
Nancy Hall	Nancy Gold 2/	34	Yellow tinged with salmon Deep orange	Spindle-shaped	For home use in the South; poor keeper
Triumph 3/		38	Light yellow	Cylindrical	For home use in the South; less sweet than Porto Rico; high in starch
Australian Canner			Salmon	Short tapered	New variety introduced by Miss. Agric. Expt. Sta.; firm when cooked
Ranger			Deep orange	.....	New variety introduced in Calif. for canning; large roots
Dry or Firm-Fleshed - Jerseys					
Big Stem Jersey	Maryland Golden 2/	30	Yellow Deep orange	Spindle-shaped	Preferred in the North; grown in Virginia, Maryland, and New Jersey
Yellow Jersey (Little Stem Jersey)	Orlis 2/ (i.e. Orange Little Stem or Jersey Orange)	30	Yellow Deep orange	Spindle-shaped or Ovoid	Preferred in the North; grown in Virginia and New Jersey
Hawaiian (Kanaka)			Light yellow	Spindle-shaped to chunky	Introduced in Calif. from Pacific Islands; good keeper

1/ As found by Caldwell, Moon and Culpepper (See "Sources" below)
2/ Mutations with a deep orange flesh and high in carotene content, otherwise similar to the parent variety
3/ Less soft than other varieties of this class, semi-moist

Sources:

Boswell, V.R. Commercial Growing and Harvesting of Sweetpotatoes. Washington, D.C., 1950 (U.S. Dept. of Agriculture Farmers' Bulletin 2020)

Caldwell, J.S., Moon, H.H., and Culpepper, C.W. A Comparative Study of Suitability for Drying Purposes in Forty Varieties of the Sweetpotato. Washington, D.C., 1938. (U.S. Dept. of Agriculture Circular 499)

Miller, F.W., Beattie, J.H., and Zimmerley, H.H. Sweetpotato Growing. Rev.ed. Washington, D.C., 1940. (U.S. Dept. of Agriculture Farmers' Bulletin 999)

Minges, P.A., and Morris, L.L. Sweet Potato Production in California. Berkeley, Calif. Agric. Extension Service (1949)

TABLE II

Sweetpotato Production, Acreage, Yields, and Prices for Principal Producing States

State	Ten-Year Average - 1940 through 1949 Production (Tons)	Acreage (Acres)	Yield Tons/Acre	Price $/Ton	1950 Price $/Ton	1951 Price 1/ $/Ton	Leading Variety Grown
Louisiana	241,000	98,000	2.5	49	36	105	Porto Rico
North Carolina	197,000	68,000	2.9	66	72	107	Porto Rico
Georgia	180,000	84,000	2.2	65	72	120	Porto Rico
Texas	148,000	60,000	2.5	67	64	125	Porto Rico
Alabama	148,000	68,000	2.2	67	78	102	Porto Rico
South Carolina	146,000	56,000	2.6	61	65	104	Porto Rico
Mississippi	141,000	57,000	2.5	68	73	122	Porto Rico
Virginia	90,000	28,000	3.2	59	62	96	Maryland Golden
New Jersey	60,000	16,000	3.8	81	60	122	Jerseys
California	32,000	11,000	2.9	109	99	167	Porto Rico
All Other States	299,000	120,000	2.5	--	--	---	
U.S. Total	1,682,000	666,000	2.5	64	61	111	

1/ Calculations based on prices the farmers were receiving on December 15th.

Based on data published in:

U. S. Dept. of Agriculture, Agricultural Statistics, 1942-50 Washington, D. C., 1942-50

U. S. Bur. of Agric. Economics. Crop Production ... Annual Summary, Washington, D. C., 1951

U. S. Bur. of Agric. Economics. AGRICULTURAL PRICES - issue of Dec. 29, 1951.

U. S. Bur. of Agric. Economics. Farm Production, Farm Disposition, and Value of Principal Crops, 1949-50. Washington, D. C., 1951

TABLE III

Sweetpotatoes Sold by Farmers in Principal Producing States in 1950

State	Quantity Sold (Tons)	Proportion of Production Actually sold (Per cent)	State's Proportion of Total Sales in U. S. (Per cent)
Louisiana	177,000	63	23.1
Texas	90,000	63	11.8
North Carolina	74,000	40	9.7
South Carolina	66,000	43	8.6
New Jersey	66,000	83	8.6
Virginia	53,000	62	6.9
Georgia	45,000	28	5.9
California	35,000	81	4.6
Alabama	28,000	20	3.7
Mississippi	26,000	22	3.4
All other States	105,000	46	13.7
Total United States	765,000	47	100.0

Computed from data in:

U. S. Bur. of Agric. Economics. Farm production, Farm Disposition, and Value of Principal Crops. 1949-50. Washington, D. C. 1951

TABLE IV

Usual Planting and Harvesting Seasons for Sweetpotatoes in Principal Producing States

State	Planting	Harvesting	Growing Districts
Texas	Apr. 15 - May 31	Aug. 15 - Oct. 15	Eastern
Louisiana	Apr. 1 - May 31	July 15 - Nov. 15	Southern
Mississippi	May 1 - June 10	Sept. 1 - Nov. 10	State wide
Alabama	Apr. 1 - June 15	July 15 - Nov. 15	State wide
Georgia	Apr. 1 - June 15	Sept. 1 - Nov. 15	State wide
South Carolina	Apr. 15 - June 15	Sept. 1 - Nov. 10	State wide
North Carolina	May 1 - May 31	Sept. 5 - Nov. 10	Coastal plain
Virginia	May 1 - June 25	Aug. 10 - Nov. 10	Coastal plain
New Jersey	May 5 - May 31	Aug. 25 - Oct. 25	Southern
California	May 20 - June 25	Sept.15 - Dec. 20	San Joaquin Valley

Based upon data in:
U. S. Bur. of Agric. Economics. Usual Planting and Harvest Time for Major Field Crops and Commercial Vegetables for Fresh Market by States. Washington, D? C., 1948

Sources of Information

Bosewell, V. R. Commercial Growing and Harvesting of Sweetpotatoes. Washington, D.C. 1950 (U.S. Dept of Agriculture Farmers' Bulletin 2020) 38 p.

Caldwell, J.S.; Moon, H. H.; and Culpepper, C. W. A Comparative Study of Suitability for Drying Purposes in Forty Varieties of the Sweetpotato. Washington, D. C., 1938 (U.S. Dept. of Agriculture Circular 499) 51 p.

Harter, L. L. Sweetpotato Diseases. Rev. ed. Washington, D. C., 1944 (U. S. Dept. of Agriculture Farmers' Bulletin 1059) 26p.

Lutz, J. M., and Simons, J. W. Storage of Sweetpotatoes. Rev. ed. Washington, D.C., 1948 (U.S. Dept. of Agriculture Farmers' Bulletin 1442) 50 p.

Miller, M. E. ; Ford, K. E.; and Woodin, M. D. An Economic Study of the Dehydration of Sweetpotatoes for Feed in Louisiana, Baton Rouge, 1949 (Louisiana Agriculture Experiment Station Bulletin 437) 31 p.

Minges, P. A., and Morris, L. L. Sweetpotato Production in California. California Agric. Extension Service (1949) 20 p.

CHAPTER III

PLANT PROCEDURES AND FACILITIES

This section gives pertinent information concerning the operating procedures and the facilities required for the sweetpotato dehydration plant. The information is classified and presented in accordance with the classification key given in Appendix D ("Operation Classification Code") of Volume I. The accompanying flow-sheet, drawings of equipment and facilities, and other illustrative material have been labeled in accordance with this same classification. (Note: This same classification key has been used in compiling the "Cost of Facilities" and "Total Production Costs", and thus affords a useful cross-reference system for identifying or discussing any phase of the operations and/or costs.)

The operational procedures and other facilities needed for this proposed sweetpotato dehydration plant are presented in accordance with the attached flow-sheet (Figure 2). A floor-plan (Figure 3) is given to show the space and arrangement required for the facilities.

100 -- RAW MATERIALS

The problems and methods of procuring a suitable supply of sweetpotatoes for a dehydration plant have been discussed in "Supply of Sweetpotatoes" elsewhere in these plant plans.

200 -- MANUFACTURING OPERATIONS

210 -- Raw Material Handling

211 -- Weighing

It is assumed that the truck-loads of sweetpotatoes will be weighed at the plant.

212 -- Unloading and storing at the plant

A 5- to 7-day supply of raw sweetpotatoes will be kept at the plant to assure smooth and continuous operation of the plant. Pallets have been provided for holding a 7-day supply of sweetpotatoes at the plant. Crates have been provided for holding a 90-operating-day supply of raw commodity. These crates probably will be handled on an exchange basis when purchases are made from shippers. Other crates will be acquired on purchases of raw commodity which include crates. The crates used in handling sweetpotatoes are standard James bushel crates (36 to 45 cents each) measuring approximately 13" x 14" x 17", holding 55 pounds uncured commodity or 50 pounds cured-and-stored commodity.

It is assumed in this operation that the processor receives cured raw material from shippers or other sources. It is also assumed that adequate commercial storage capacity is available for the complete operating

season (fall and winter months). To assure a steady supply of raw commodity, some processors provide their own storage house (which must be maintained at about 55°F.) for 30 to 90 operating days. Storage houses for sweetpotatoes may cost $0.75 to $1.00 per bushel-capacity. Approximately 20,000 sq. ft. (gross) is required per 100,000 crates.

213 -- Feeding to Line

A plant processing 100 raw tons per 20 operating-hour-day will require feeding 5 tons per hour. Operators will feed 10 crates every 3 minutes into the hopper of the first elevator. One or two women may be stationed alongside the first elevator to sort out "rots". This is especially desirable toward the end of the processing season when raw commodity quality is low.

215 -- Handling and returning crates

The empty crates will be palletized and returned to the shipper, or stored until the next season.

220-230 -- Preparing

A diagrammatic sketch of the "preparation line" for the proposed sweetpotato plant is given in Figure 4.

221 -- Washing

For very dirty sweetpotatoes, sprays may be installed over the elevator for preliminary washing or loosening of dirt. A rod-type rotary washer is provided, where the sweetpotatoes are tumbled while exposed to sprays of water.

222 -- Preheating

Preheating of sweetpotatoes before processing has been found to reduce darkening, to result in lower peeling and trimming losses, and to give a better quality product. The roots are heated in water at 130°F. to 135°F. for approximately 30 minutes. A draper-type preheater is provided for this operation. Rotary preheaters also have been used quite satisfactorily, but because of size limitations the capacities of these units range about 30 to 35 tons per day. Multiple units therefore would be required for a 100-ton-per-day plant.

223 -- Peeling (Steam)

223.3 -- Peeling

Peeling losses are assumed to be 15%. With poor grades of sweetpotatoes losses may run up to 20 to 30 per cent; on top grades losses may be as low as 8 to 10 per cent. An incomplete peeling job will result in lower peeling losses, but this will be off-set by higher trim and inspection loss and by increased preparation labor cost.

Steam-peeling has been provided in the proposed plant. The steam-peeler must be designed for a maximum pressure of 120 p.s.i. to ensure peeling of all types of raw material. Conditions for steam-peeling of sweetpotatoes must be determined by test, but are generally conducted at 70 to 120 p.s.i. for 25 to 30 seconds exposure time.

Lye peeling also has been used quite extensively for sweetpotatoes and is preferred by many operators. The lye-peeled sweetpotato is a smoother-appearing product than one that has been steam-peeled. In canning of sweetpotatoes this is desirable, but in dehydration the product is diced and the appearance of the peeled root does not matter. Some of the problems and disadvantages of lye-peeling include:

(a) Penetration is deeper and hence peeling losses are higher

(b) Corrosiveness and health hazard of lye must be considered

(c) Disposal of spent lye may be bothersome

(d) Trimmings from lye-peeled sweetpotatoes are not suitable for stockfeed unless given considerable washing

(e) Thorough washing of product is necessary to remove last traces of lye

(f) Lye storage and make-up facilities must be provided

(g) During an emergency, shortage of lye, steel drums, tank cars, etc., may limit operations

(h) Laboratory control is necessary with lye-peeling

Notwithstanding these disadvantages, lye is still used by some plants because it is known that with proper selection of peeling conditions it will always do the peeling job.

223.9 -- Washing

This washing operation is actually the finishing step for the peeling operation. Skins which have been loosened in the peeler are washed off by the tumbling action of the sweetpotatoes while exposed to sprays of water. Spray pressure should not be too high, or pitting and gouging will result.

224 -- Trimming

The trim line normally will require 60 to 70 women. For poor grade material, up to 80 trimmers may be required. The trimming line must be organized so that individual pieces of material do not travel the "merry-go-round" circuit too long, as darkening of the product may result through prolonged exposure of the peeled commodity to air. Some operators have flumed or sprayed the product through the trimming line to reduce darkening.

Trimming losses have been estimated to be 17% of the original raw material. Actual trimming losses may vary from 5% to 30%, or even higher, depending on the condition of the raw stock, peeling efficiency, discoloration, etc.

226 -- Holding, elevating, and dicing

The nature and relationship of the blanching and drying operations require that a steady source of prepared material be available for continuous 24-hour operation. Hoppers must be provided at the end of the

trimming line, capable of holding prepared commodity equal to 1/2 to 1 hour of operation. This will help smooth out irregularities or interruptions at any stage of the processing line. Total hopper capacity should be approximately 75 to 150 cu. ft. These hoppers may be custom-built, or may be furnished by the manufacturer supplying the elevators feeding the cutters. Water immersion holding is desirable in these hoppers.

Sweetpotatoes for military use are cut to 3/8" x 3/8" x 3/8" dice, or to 3/8" x 3/8" x 3/16" half-dice. The smaller size gives higher drying rates and greater production capacity per dehydrator. At least one extra cutting machine and plenty of spare parts are needed to assure maximum and continuous production.

227 -- Spreading, blanching, and sulfiting

For blanching, the diced commodity is loaded directly onto the blancher belt at about 4 lbs. per sq. ft. (about 1" deep) and exposed to steam at 200 - 210°F. for 5 to 7 minutes. A vibrating blancher-loading device is included to maintain a uniform layer of material across the full width of the blancher belt. This is necessary to provide equal and uniform loading on each of three conveyor belts feeding the driers as well as to assure uniform blanching. The product discharged from the blancher drops directly onto the three belts.

A stainless steel blancher belt has been specified in this operation, The additional cost of stainless steel is well justified. Less corrosion and longer equipment life will result, smooth and continuous operation will be assured, and rust contamination of the product will be eliminated.

Sulfiting of sweetpotatoes, as with most vegetables, is done in a manner which is best determined by trial. Military specifications require 200 to 500 p.p.m. (as SO_2) in the finished product. In the proposed operation, sulfite is applied by sprays installed over the belt on the discharge end of the blancher. Solutions of sulfites in concentrations from 0.2% to 1.0% are applied at a rate of approximately 1 gal. to 10 to 50 pounds of commodity.

240 -- Drying

Sweetpotatoes may be successfully dried in either truck-and-tunnel or in continuous conveyor belt driers. Continuous conveyor belt driers were chosen for this proposed plant for several reasons:

(1) Of all the commodities considered in this Handbook, sweetpotatoes are probably the best suited commodity for a continuous conveyor drying operation:

(a) Diced material is uniform in size and shape, and thus may be loaded in layers of uniform depth and consistency

(b) Diced sweetpotatoes may be dried in deep beds and with high temperatures (do not scorch easily)

(c) Diced sweetpotatoes are not likely to fracture under the handling conditions of a continuous belt drier

(2) Dehydrated sweetpotatoes were successfully prepared for military requirements during World War II by at least two operators using continuous conveyor belt driers.

242 -- Conveyor drying

242.1 -- Conveying and spreading

Three separate rubber-belt conveyors are specified for feeding the driers from the blanching and sulfiting operations. These belts discharge directly onto the cross-conveyor furnished by the drier manufacturer for feeding and spreading for each drier.

242.2 -- Conveyor drier operating

The conveyor driers proposed in this set of plans have been rated by the manufacturer at about 400 lbs. per hour output each for drying white potatoes. Sweetpotatoes average much higher in solids content than white potatoes, and an equivalent weight of raw sweetpotatoes will produce about 67% more dry product than white potatoes. Therefore, with only the rated evaporation load imposed upon each of the proposed driers, the three driers may produce a total of as much as 2,000 lbs. per hour of dried diced product.

Although production in this plant is based upon 20-hour daily operation, the driers must be operated continuously 24 hours daily. This must be done so that a continuous and uniform layer is maintained on the dehydrator belt to prevent air from short-circuiting through open spaces and to maintain uniform drying of product. The requirements based on continuous drier operation, of 1,700 lbs. per hour of dried product, should be met without difficulty by using three driers. Another assurance of ample production capacity is that the continuous conveyor belt driers need dry the commodity to only about 11% product moisture (as the final drying will be done in bins).

Continuous conveyor belt dehydrators for sweetpotatoes allow some flexibility of operating conditions. The proposed driers (see Figure 5) operate in two stages ("A" and "B" stages). The six units (one unit consists of the section served by each circulating fan and heating bank) in stage "A" may be operated as three sections consisting of 2 units per section, or as two sections consisting of 3 units per section. All of the units within a section operate at the same temperature. The two units in stage "B" operate at a common temperature. The following temperatures have been reported for drying sweetpotatoes in this type of equipment:

Stage "A" -- Hot end temperature in the range of 200°F. to 260°F.

-- Intermediate temperature of 180°F. to 220°F.

Stage "B" -- Finishing temperature of 160°F. to 180°F.

For maximum production of acceptable product, the optimum operating conditions must be determined on the particular type of raw commodity being processed.

242.3 -- Conveying and elevating

The products of the three driers discharge onto a cross-conveyor collecting belt, and are then elevated to a hopper-bin feeding the portable finishing bins.

248 -- Bin Drying

Bin driers have not as yet found commercial use in the drying of sweetpotatoes. Operators have indicated a belief, however, that use of bins definitely improves the flexibility of the drying operation, and, in this case where continuous conveyor belt driers are used, bins would allow closer control in meeting moisture specifications. In effect, it provides relatively simple and inexpensive equipment to assume part of the load of the more costly conveyor driers.

The proposed sweetpotato plant uses portable bins and a bin room designed on the basis of the following data:

1) Air flow rate through bins - 100 c.f.m. per sq. ft. of cross-section

2) Inlet air temperature to bins - 140°F. to 160°F.

3) Drying time - 6 to 8 hours

4) Bulk density of dried sweetpotato dice (Approx. 11% moisture content) - 25 lbs. per cu. ft.

5) Depth of material in bins - 4 feet

248.1 -- Bin loading

The design of the portable bins is shown in Figure 7. The dimensions of these bins are 3 ft. wide by 5 ft. long by 5 ft. high.

248.2 -- Bin operating

It is anticipated that 8 bins will give adequate capacity for plant production during normal weather conditions. Four extra bins are provided for loading, unloading, holding, and to allow for periods when slow-finishing drying is encountered. Space is provided for a total of 12 bins on the two heated-air ducts.

Two banks of bins are used. The product coming from the conveyor-driers is put into bins which are first dried in Bank "A" and later transferred to Bank "B" for the final drying. The two banks operate as follows: dehumidified, heated air is blown through Bank "B", and the effluent air from these bins is caught by an over-head hood, reheated and then passed through the bins in Bank "A". The two-bank system is desirable even though it requires shifting the bins during the bin-finishing operation. The two-bank method

is particularly advantageous for operating in areas having very high atmospheric humidity, a condition quite likely to be encountered in desirable areas for growing sweetpotatoes.

A suggested arrangement for the bin room is shown in Figure 3.

248.3 -- Bin unloading

For unloading, the bins are lifted by means of an electric hoist and dumped into the hopper feeding the screening operation.

250 -- Screening and Inspection

252 -- Screening

Military specifications require that not more than 1% by weight of the dehydrated product may pass through a U. S. Standard sieve containing 8 meshes to the inch (0.0937 inch openings). Screening is therefore required to remove the material that is too fine in size to meet these requirements. (In some plants operating on various vegetables, a magnet is installed at this point to remove iron contamination in the product.) The "Fines" produced in this plant have been assumed to be 5%, based on the original raw material processed. With good operating procedures, "fines" may run as low as 1%.

255 -- Inspecting

After being screened, the product is inspected for discolored pieces, peel fragments, etc. The inspection is done while the dehydrated and screened product is carried along a continuous conveyor belt to the packaging operation. "Defects" have been estimated to be 3%, based on the original raw material processed.

260 -- Packaging and Packing

261 -- Filling, weighing, and closing

In this plant, the rate of handling of cans is low (557 per hour) and expensive automatic equipment to fill and weigh the cans is not justified.

In the proposed filling operation, cans are fed manually into the can run, and then automatically placed in register with the can-filling opening. The entire can-carrying table revolves, as well as the center bowl carrying the product to be pachaged. The product is manually brushed into the filling openings by the operators. The feed bowl is supplied from an overhead hopper by operating a gate as required.

The filled cans are conveyed from the filling machine past two manual weighing stations, and continue on to a conventional closing machine. The specifications require that a leaflet giving cooking directions be placed in each can. Some saving in labor may be effected by operating intermittently on filling, weighing, and closing, and by shifting personnel from the dried product inspection line as required.

Cans should be purchased with lithographed labels as required in the specifications. The date is stamped on each can at the time of packaging.

262 -- Case forming, filling, sealing, marking

Specifications permit the use of either wood boxes or fiberboard cartons of definite types; the military bids and contracts will specify the exact types of packing to be supplied by the dehydrator. Existing dehydrators use either mechanical or manual casing operations.

270 -- Warehousing and Shipping

In keeping with the current trend, the proposed plant utilizes pallets for handling and storing of the finished product in the warehouse.

GENERAL FACILITIES

The requirements for other needed facilities have been discussed in Volume I, and the information will not be repeated here. The principal "general" facilities for the sweetpotato plant are listed in the "Cost of Facilities" for this proposed plant; included are items for utilities, maintenance and repairs, inspection and control, miscellaneous plant facilities, automotive, and administrative facilities and supplies.

325 -- Waste Disposal

The waste material from the preparation line will be conveyed into an overhead hopper. This hopper should be located to permit trucks to back under the discharge chute to remove the trimmings. These solid wastes would most likely be used for stock feed, but they may have to be trucked to the dumps.

The waste water from a sweetpotato dehydration plant will be screened to take out the major part of the suspended waste solids. The liquid waste might then be run into available sewers, streams or irrigation ditches, or into seepage ponds, lagoons, or waste land, depending upon what is available and upon local or state regulations.

BUILDINGS AND GROUNDS

Buildings and grounds for a sweetpotato dehydration plant should conform with the general requirements described in Volume I under "Plant Location" and "Establishment and Operation of a Suitable Plant". A minimum of 3 acres of land should be provided for the sweetpotato plant depicted herein; more acreage would be advisable in many cases.

Figure 3 shows a suggested plant layout. The various processing steps are located to permit ready expansion if desired. Raw commodity and product storage areas are adjoining to provide flexibility of space as required; if more space is required, expansion away from the plant proper is possible. The entire preparation line may be expanded into the area designated for auto parking. Conveyor drier and bin drier areas may expand away from the building proper as shown in Figure 3. Inspection and packaging operations may expand into the finished product storage space.

The boiler room is shown detached from the buildings. Approximately 25 feet separation is the minimum to obtain lower fire insurance rates. A detached boiler house also affords better accessibility for servicing the repairing the boilers.

The location of the offices, laboratory, rest rooms, and lunch room is only suggestive. These could be rearranged without seriously affecting plant operation.

Floor drains should be provided in the preparation area, particularly under the washers (Codes 221 and 223.9), trimming tables (Code 224), and blancher (Code 227).

CHAPTER IV

COST OF SWEETPOTATO DEHYDRATION FACILITIES

Cost Summary

100 -- RAW MATERIAL PROCUREMENT FACILITIES		
170 -- "Crates, Boxes, & Sacks" (wood crates) . . .	$144,000	
Total for RAW MATERIAL PROCUREMENT FACILITIES		$144,000
200 -- MANUFACTURING OPERATIONS FACILITIES		
210 -- "Raw Material Handling" Equipment	$ 17,315	
220-230 -- "Preparing" Equipment	92,735	
240 -- "Drying" Equipment	233,310	
250 -- "Screening & Inspecting" Equipment	3,050	
260 -- "Packaging & Packing" Equipment	12,770	
270 -- "Warehousing & Shipping" Equipment	8,480	
Total for MANUFACTURING FACILITIES		$367,660
300 -- GENERAL FACILITIES		
320 -- "Utilities" Equipment	$ 66,545	
330 -- "Maintenance & Repairs" Equipment & Supplies	15,000	
380 -- "Inspection & Control" Equipment	5,000	
390 -- "Miscellaneous Plant" Equipment	5,700	
400 -- "Automotive" Equipment	3,500	
690 -- "Office & First Aid" Equipment & Supplies .	5,000	
Total for GENERAL FACILITIES		$100,745
Total for Plant Equipment (TABLE I)		$612,405
Total for Buildings & Grounds (TABLE II)		205,000
Construction Engineering Fees		30,000
TOTAL COST FOR ITEMIZED PHYSICAL FACILITIES FOR SWEETPOTATO DEHYDRATION PLANT		$847,405

Critical Materials in the Equipment for a 100-ton per Day Sweetpotato Dehydration plant

Material	Estimated Total No. of Pounds in Equipment	Percentage of Total Weight of Critical Materials
Iron and Steel	430,000	96.80
Copper	1,800	0.41
Stainless Steel	11,000	2.48
Zinc	400	0.09
Tin	100	0.02
Rubber	900	0.20
	444,200	100.00

Disclaimer Statement

The designation of any manufacturer or brand-name equipment does not imply a specific recommendation by the Department of Agriculture. Such inclusion means only that these particular items have been found satisfactory for the purpose indicated; other sources and items may prove equally satisfactory. Additional information concerning suggested manufacturers of equipment may be found in"Additional Sources of Information" (Volume I, Appendix C)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
			100 -- RAW MATERIAL PROCUREMENT FACILITIES			
170 -- Crate, Box, and Sack Expense						
	a. Crates: For handling sweetpotatoes from field to plant	Standard James	50 lb. bushel crate - 13" x 14" x 17"	360,000	$0.40	$144,000
	TOTAL COST OF "RAW MATERIAL PROCUREMENT" FACILITIES					$144,000
			200 -- MANUFACTURING OPERATIONS FACILITIES			
210 -- RAW Material Handling						
211 -- Weighing (at plant)						
	a. Truck scales: To weigh incoming loads of raw material (not required for plants having access to public scales)	Fairbanks Morse Code 6512 (13,700 lbs)	Platform 60' x 10', capacity 50 tons. Equipped with type registering beam. Includes structural steel for timber deck. Cost includes $350 installation charge, and does not include pit	1	$3,750	$ 3,750
	b. Pit & housing for scales		Estimated cost for constructing pit and housing for scales			3,000
212 -- Unloading & storing (at plant)						
	a. Lift truck: To handle palletized raw material and other loads within the plant	Yale Model KG 51-T-40-V (7,300 lbs)	Capacity 2 tons, gasoline engine	1	4,080	4,080
	b. Pallets: For handling raw sweetpotatoes and empty crates within plant		Wood - 48" x 60"; double faced	1,000	4	4,000
213 -- Feeding to line						
	a. Elevator: To serve as dumping point for crated raw material, and to elevate sweetpotatoes to first washer	FMC 1/ Fig. 8657 (700 lbs)	12" wide x 68" discharge height, cleated rubber belt elevator with steel frame; complete with 1/2 h.p. motor drive	1	$1,100	$ 1,100
			Sub-total			$ 15,930
Allowance for Freight Charges (factory-made equipment)			- 22,000 lbs. at 5¢/lb			1,100
Allowance for Installation Charges - 25% of equipment			plus freight cost ($1,135) 2/			285
	Total Cost of "Raw Material Handling" Equipment					$ 17,315
220-230 -- Preparing						
221 -- Washing						
	a. Washer: To wash dirt from raw sweetpotatoes	FMC Fig. 9331 (2,300 lbs)	43" diameter x 12' long, rotary rod type washer, all-steel construction; with centrally located spray pipe and adjustable discharge baffle; complete with 2 h.p. splash-proof motor drive	1	$3,000	$ 3,000
222 -- Preheating						
	a. Preheater: To preheat sweetpotatoes to facilitate peeling and to reduce darkening during processing	FMC Fig. 9333 (9,000 lbs)	48" wide draper x 47' tank length; hot water preheater; all-steel construction with black iron slat and flight draper carried by side chains; complete with 3 h.p. variable speed motor drive for 30 min. max. retention time	1	9,410	9,410

1/ Food Machinery & Chemical Corp.
2/ Equipment cost based on F.O.B. manufacturer's price plus allowance for freight charges at 5¢/lb

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
b.	Controls: To regulate and control temperatures in the preheater	Taylor: #86RV323 #6VP255 #R89S17 #R41S323 (125 lbs total each set)	Each control set consisting of: Indicating temperature controller Reverse-acting diaphragm valve (1-1/4") Air filter Air reducing valve (1/4")	2	$ 260	$ 520
223 -- Peeling						
223.3 -- Steam peeling						
a.	Steam peeler: To peel sweetpotatoes by steaming of skins	FMC Fig. 8689 (11,500 lbs)	Continuous high pressure steamer, ASME construction, for max. operating pressure of 120 p.s.i.; with feed elevator, platform for 6' discharge height, 3' extended shell, variable speed, 7/1/2 h.p. motor drive, and temperature control instruments; separate 5 h.p. variable speed motor on screw	1	15,945	15,945
223.9 -- Washing						
a.	Washer: To wash loosened skins from raw sweetpotatoes	FMC Fig. 9331 (2,300 lbs)	43" diameter x 12' long, rotary rod type washer; all steel construction; with centrally located spray pipe and adjustable discharge baffle; complete with 2 h.p. splash-proof motor drive	1	3,000	3,000
224 -- Trimming and inspecting						
a.	Cross conveyor: To convey and distribute peeled sweetpotatoes from washer to trim tables	FMC Fig. 5030 (1,000 lbs)	24" wide x 15' center-to-center, rubber belt conveyor, steel frame construction, belt supported by steel rollers with oilite bearings, complete with 1-1/2 h.p. motor drive	1	1,385	1,385
b.	Trimming and inspecting tables: To convey peeled sweetpotatoes during final trimming and inspection before dicing	FMC Fig. 9318 (5,500 lbs. each)	Merry-go-round trim tables consisting of 3 parallel 12" wide x 50' long center-to-center rubber belt conveyors; outer belts for trimming and with divided lanes for trimming, inner belt to be raised so that return side acts as merry-go-round return for overflow from outer belts, top side for conveying trimmed product to discharge point; all steel construction with belts carried on steel rollers with oilite bearings; complete with 3 h.p. motor drive	2	6,455	12,910
226 -- Cutting (dicing)						
a.	Hoppers and elevators: (1) Hoppers: To hold peeled sweetpotatoes for regulating flow during lunch periods, etc.	Custom built	75 cu. ft. capacity, galvanized iron, to fit elevator boot and to hold peeled sweetpotatoes under water	2	100	200
	(2) Elevators: To elevate trimmed sweetpotatoes to dicers	FMC Fig. 8657 (1,550 lbs each)	24" wide x 13' discharge height; cleated rubber belt elevator with steel frame; complete with 1/2 h.p. motor drive	2	2,210	4,420
b.	Cutters (dicers): To cut prepared sweetpotatoes to 3/16" x 3/8" x 3/8" size	Urschel Model B Dicer (750 lbs each)	Dicer with one extra slicing knife, 6 extra circular knives, and 6 extra cross-cut knives; complete with 2 h.p. splash-proof motor drive	3	1,410	4,230
227 -- Blanching and sulfiting						
a.	Spreader: To load (and spread uniformly) the diced product on the blancher belt	Syntron Model F44 "Twin" (5,200 lbs)	6'10" wide trough of stainless steel; height 35" to back of trough; with magnetic vibrators	1	$ 2,730	$ 2,730
b.	Blancher: To blanch the diced product before drying	FMC Steam Blancher Fig. 9332 (10,000 lbs)	7' wide x 40' overall length; with stainless steel woven wire draper; with spray section at feed and discharge end; complete with 5 h.p. variable speed drive to provide maximum blanch time of 7 min.	1	12,575	12,575

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
c.	Controls: To regulate and control temperatures in the blancher	Taylor #86RV323 #6VP255 #R89517 #R41S323 #12EU310 (125 lbs total each set)	Each control set consisting of: Indicating temperature controller Reverse-acting diaphragm valve (1-1/4") Air filter Air reducing valve (1/4") Thermometer (120-220°F.)	2	$ 275	$ 550
d.	Sulfite make-up equipment: (1) Tanks: To mix and hold sulfiting solutions	Pacific Wood Tank Co. (500 lbs. each)	500 gallon fir-wood tank, 4' high	2	100	200
	(2) Sulfite pump: To deliver sulfite solution from storage to spray nozzles at sulfiting end of blancher	Tri-Clover Model 1 CR (100 lbs)	Centrifugal type sanitary pump; 1-1/4" x 1"; bronze; complete with 1/2 h.p. motor	1	110	110
			Sub-total			$ 71,185
Allowance for Freight Charges (factory-made equipment)			- 60,000 lbs. at 5¢/lb			3,000
Allowance for Installation Charges - 25% of equipment			plus freight cost ($74,185)			18,550
	Total Cost of "Preparing" Equipment					$ 92,735
240 -- Drying						
242 -- Conveyor drying						
242.1 -- Conveying						
b.	Conveyor: To convey blanched product from blancher to dehydrator No. 1	FMC Fig. 5030 (1,700 lbs)	24" wide x 40' center-to-center rubber belt distributing conveyor; steel frame construction; belt supported by steel rollers with oilite bearings; complete with 1-1/2 h.p. motor drive	1	2,400	2,400
b.	Conveyor: To convey blanched product from blancher to dehydrator No. 2	FMC Fig. 5030 (1,400 lbs)	24" wide x 24' center-to-center rubber belt distributing conveyor; steel frame construction; belt supported by steel rollers with oilite bearings; complete with 1-1/2 h.p. motor drive	1	2,000	2,000
b.	Conveyor: To convey blanched product from blancher to dehydrator No. 3	FMC Fig. 5030 (700 lbs)	24" wide x 6' center-to-center rubber belt distributing conveyor; steel frame construction; belt supported by steel rollers with oilite bearings; complete with 1-1/2 h.p. motor drive	1	990	990
242.2 -- Drying						
a.	Dehydrator: To dry diced sweetpotatoes to 9-11% moisture content	Proctor & Schwartz Continuous Conveyor Dehydrator (65,000 lbs each)	6 Unit "A" and 2 Unit "B" two-stage continuous conveyor drier; 75 ft. long, with stainless steel belt; complete with wiper-type feed, motors, starters, temperature controls, instruments, exhaust fans, steam coils, etc.	3	48,000	144,000
242.3 -- Conveying						
a.	Conveyor: To collect and convey the dried product from the dehydrators to the elevator	FMC Fig. 5030 (1,700 lbs)	24" wide x 40' center-to-center rubber belt distributing conveyor; steel frame construction; belt supported by steel rollers with oilite bearings; complete with 1-1/2 h.p. motor drive	1	2,500	2,500
b.	Elevator: To elevate dried product to bin loading hopper	FMC Fig. 542 (1,400 lbs)	Gooseneck conveyor-elevator; discharge height 10'; 16" wide buckets; complete with 1 h.p. motor drive	1	820	820
			Sub-total			$152,710
Allowance for Freight Charges (factory-made equipment)			- 202,000 lbs. at 5¢/lb			10,100
Allowance for Installation Charges - 25% of equipment			plus freight costs ($162,810)			40,705
	Total Cost of "Conveyor Drying" Equipment					$203,515
248 -- Bin drying						
248.1 -- Bin loading						
a.	Bins: To hold sweetpotato pieces during the final drying stage	Custom built (See Fig. 6)	3' wide x 5' long x 5' high; sheet metal or plywood construction; mounted on casters and equipped with ring for dumping by means of a hoist; metal screen to serve as false bottom; 12 inch diameter air duct	12	65	780

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
248.2 -- Bin operating						
a.	Dehumidifier: To provide low humidity air for bin drying	Pittsburgh Lectrodryer Type CH Size U (25,000 lbs)	Multi-adsorber unit providing continuous and automatic reactivation of alumina; without aftercooler; 10,000 c.f.m. air flow; complete with 10 h.p. motor	1	$15,330	$ 15,330
b.	Blowers: To circulate air through heating coils and drying bins	Sturtevant Silentvane No. 80 Design 10 Class II (875 lbs each)	Single width; bottom horizontal discharge; 10,000 c.f.m. at 5" S.P.; including 15 h.p. motor and drive	2	1,000	2,000
c.	Heating coils: To heat air going to the drying bins	Aerofin Corp. TypeFF Non-freeze Coil, Series 80 (400 lbs each)	Bank of coils, 3 rows deep, consisting of one section 24 tube face, 4' tubes (No. 82), plus one section ditto (No. 81)	2	600	1,200
d.	Ductwork: To carry air from outside of building, conduct it through fans and heating coils (and dehumidifier), and to each of 12 drying bin positions	Custom built	Horizontal run laid on floor, 35' long, 10 sq. ft. cross section; 6 outlets on one vertical face, spaced 5' apart, each outlet with transition to 12" diameter collar	2	1,250	2,500
e.	Hood and ducts: To collect air leaving bins for recirculation	Custom built	Approx. 7' x 30' hooded section mounted several inches above top of bins; single exhaust duct	1	1,500	1,500
248.3 -- Bin unloading						
a.	Hoist: To elevate the drying bins for dumping dried product	Yale Midget King Electric Hoist, Model No. IE17H (140 lbs)	Hook type 2,000 lb. capacity; 10 ft. lift; 17 f.p.m.; 1 h.p.	1	360	360
			Sub-total			$ 23,670
Allowance for Freight Charges (factory-made equipment) - 28,000 lbs. at 5¢/lb						1,400
Allowance for Installation Charges - 25% of equipment			plus freight cost ($18,890)			4,725
			Total Cost of "Bin Drying" Equipment			$ 29,795
			Total Cost of "Conveyor Drying" Equipment			203,515
			Total Cost of "Drying" Equipment			$233,310
250 -- Screening and Inspecting						
252 -- Screening						
a.	Magnet: To remove any particles of iron and steel	FMC (Cesco) (20 lbs)	Steel face plate, 12" wide; standard model	1	90	90
b.	Shaker screen: To screen out "fines" from dehydrated product	Link-Belt UP 125 (870 lbs)	2' x 5' unbalanced pulley type; one screen section on single deck; 2 h.p. motor	1	600	600
255 -- Inspecting						
b.	Conveyor-sorter: To convey the product past the final inspection stations	FMC Fig. 5031 (1,300 lbs)	30" wide x 16' center-to-center white rubber belt; steel frame construction; with 1 h.p. motor	1	1,640	1,640
			Sub-total			$ 2,330
Allowance for Freight Charges (factory-made equipment) - 2,200 lbs. at 5¢/lb.						110
Allowance for Installation Charges - 25% of equipment			plus freight cost ($2,440)			610
			Total Cost of "Screening and Inspecting" Equipment			$ 3,050

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
260 -- Packaging and Packing						
261 -- Filling, packing, and sealing						
a.	Elevator: To elevate product to can filling hopper	FMC Fig. 542 (1,000 lbs)	Gooseneck conveyor-elevator, discharge height 6', 16" wide buckets, complete with 1 h.p. motor drive	1	$ 755	$ 755
b.	Filling machine: To deliver the product into No. 10 cans	FMC Handpack Filler Fig. 46-10 (1,500 lbs)	Product is fed into a hopper which rotates along with the can-carrying table; all parts in contact with product are stainless steel; complete with 1 h.p. constant speed motor drive and motor-driven vibrator	1	1,815	1,815
c.	Scales: To check weigh exact amounts into cans	FMC Fig. 2150 (55 lbs. each)	Model 1C-72-05 Detectogram general purpose scale; 10 lbs. capacity	2	115	230
g.	Closing machine (seamer): To seal covers on cans	American Can Co. No. 1 (1,050 lbs)	Semi-automatic machine operated by depressing foot treadle for each seaming operation; includes 1-1/2 h.p. drive	1	850	850
h.	Conveyor: To convey filled cans past check weighing stations, and to closing machine	FMC Special attachment to Filler (300 lbs)	7" wide x 8' long, leather belt conveyor	1	500	500
262 -- Case forming, filling, sealing, and marking:						
a.	Case branding machine: To print required markings on cases	FMC Fig. 8072 (2,225 lbs)	Automatic machine equipped to handle box shook and flat fibre cases; complete with 1 h.p. motor and variable speed drive	1	1,980	1,980
b.	Case sealing machine: To seal top and bottom flaps on cases	Elliott Model A (4,000 lbs)	Fully automatic with 16' of compression section; complete with 3/4 h.p. motor drive on gluing section and 1/4 h.p. motor drive on compression section	1	3,535	3,535
			Sub-total			$ 9,665
Allowance for Freight Charges (factory-made equipment)			- 11,000 lbs. at 5 ¢/lb.			550
Allowance for Installation Charges			- 25% of equipment plus freight cost ($10,215)			2,555
			Total Cost of "Packaging and Packing" Equipment			$ 12,770
270 -- Warehousing & Shipping						
271 -- Palletizing						
a.	Pallets: For handling empty cans and filled cases		Wood; 48" x 60"; double faced	1,000	4	4,000
272 -- Warehousing						
a.	Lift truck: To move palletized loads in products warehouse	Yale Model KG 51-T-40-V (7,300 lbs)	Capacity 2 tons; gasoline engine	1	4,080	4,080
			Sub-total			$ 8,080
Allowance for Freight Charges (factory-made equipment)			- 8,000 lbs. at 5 ¢/lb.			400
Allowance for Installation Charges						None
			Total Cost of "Warehousing & Shipping" Equipment			$ 8,480
			TOTAL COST OF MANUFACTURING OPERATIONS FACILITIES			$367,660

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
			GENERAL FACILITIES			
320 -- Utilities						
321 -- Water supply						
	a. Water pump: To elevate water from well and to deliver it throughout plant at required pressure	FMC (Peerless) Deep Well Turbine Type Pump (5,300 lbs)	8 stages, 10" M.A. Sheet No. R1096, Curve 1, for 500 g.p.m. with 285' head at 80 p.s.i. delivery pressure; complete with strainer and 40 h.p. motor	1	$2,000	$ 2,000
	b. Chlorinator: To treat the water used in the plant to prevent slime formation and to improve plant sanitation	Wallace & Tiernan Type MASVM-A-421 (1,500 lbs)	Consists of chlorinator booster pump, differential converter, and main line orifice plate; converter automatically controls flow of chlorine so that the latter is always proportional to the flow of water.	1	4,500	4,500
	c. Water well: For supplying sufficient water to meet needs of plant	--	Cost includes digging and casing of well and small housing for pump motor	1	3,000	3,000
324 -- Steam supply						
	a. Steam boiler: To supply steam for operation of plant equipment, clean-up, building heating, etc.	Cleaver-Brooks, Series B, Model 20 (25,300 lbs) each)	Four-pass horizontal fire-tube boiler with integral channel iron frame and burner assembly; 200 boiler horsepower rating, 125 p.s.i. design pressure; equipped for No. 6 oil and gas; complete package unit	3	11,570	34,710
325 -- Waste Disposal						
	a. Sewage screen: To separate solids from water in sewage disposal system	FMC Fig. 1437, North Sewage Screen (8,000 lbs)	Trunnion type; with segment tooth drive screen with precision cut teeth, 6 ft. screen, No. 20-mesh bronze wire, 400 g.p.m. capacity; complete with steel tank and 3 h.p. motor	1	3,095	3,095
	b. Elevator: To elevate solid wastes from sewage screen to hopper	FMC Fig. 541 (2,100 lbs)	12" wide gooseneck conveyor-elevator with galvanized iron buckets; discharge height 20'; complete with 1 h.p. motor drive	1	880	880
	c. Hopper: To hold solid waste until trucked to dump	Custom built	10' x 10' x 6' height; with sloping sides and discharge gate; elevated clearance of 12'	1	400	400
			Sub-total			$ 48,585
Allowance for Freight Charges (factory-made equipment)			- 93,000 lbs. at 5¢/lb.			4,650
Allowance for Installation Charges - 25% of equipment			plus freight cost ($53,235)			13,310
	Total Cost of "Utilities" Equipment					$ 66,545
330 -- Maintenance and Repairs 3/						
	a. Maintenance shop equipment: To maintain plant in proper operating condition; to make necessary repairs	--	Includes welding and cutting equipment; - drill presses; cut-off saws; sheet metal cutting facilities; hand tools for carpentry, electrical, and metal work; pipe threading and cutting equipment; miscellaneous supplies	-	--	5,000
	b. Maintenance parts & supplies: Standing inventory of spare parts and maintenance supplies to assure continuous operation of the plant	--	Pipe, sheet metal, fittings, electric motors, equipment parts, welding supplies, etc.	-	--	10,000
	Total Cost of "Maintenance & Repairs" Equipment and Supplies					$ 15,000

3/ Costs indicated for these items include installation costs

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
380 -- Inspection and Control 3/						
381 -- Laboratory testing						
a.	Laboratory equipment & supplies: To do necessary control testing of processing operations and of finished products	--	Apparatus, supplies, tables, hoods, benches, and other facilities needed for tests and control purposes	-	--	$ 5,000
	Total Cost of "Inspection and Control" Equipment and Supplies					$ 5,000
390 -- Miscellaneous Plant Equipment 3/						
a.	Lunch room: To accomodate up to 50 people at a time	--	--	-	--	4,500
b.	Fire-fighting equipment: For emergency use	--	2 - 300-ft. hoses and reels; 2 emergency showers; 8 5-gal. extinguisher tanks; 12 hand extinguishers; 12 gas masks	-	--	1,200
	Total Cost of "Miscellaneous Plant" Equipment					$ 5,700
400 -- Automotive Equipment						
a.	Truck: For miscellaneous work to keep plant in proper operation	GMC	1-1/2 ton pick-up truck (delivered price)	1	$3,500	3,500
	Total Cost of "Automotive" Equipment					$ 3,500
690 -- Miscellaneous Administrative Supplies and Facilities 3/						
a.	Office furniture, supplies, and first-aid facilities: For bookkeeping, payrolls, business transactions; personnel work; first aid	--	--	-	--	5,000
	Total Cost of "Miscellaneous Administrative Supplies & Facilities"					$ 5,000
	TOTAL COST OF "GENERAL" FACILITIES					$100,745

TABLE II

BUILDING AND GROUNDS FOR A SWEETPOTATO DEHYDRATION PLANT

	Building & Grounds: Suitable building and grounds for the sweetpotato dehydration plant	--	Includes: land; and a building complete with industrial lights, utility and sewer lines within the building, toilet facilities, and loading ramps (or platform) Building - 41,000 sq. ft. at $5/sq. ft.	-	--	$205,000
	TOTAL COST OF BUILDING AND GROUNDS					$205,000

TABLE III

OPTIONAL EQUIPMENT FOR A SWEETPOTATO DEHYDRATION PLANT

321 -- Water supply						
a.	Diesel engine: For standby use for operating the well water pump	Fairbanks-Morse Co.	Diesel engine complete with fuel tank and connecting gears for attaching to well water pump. Cost for this standby service is in addition to the cost of pump equipment listed	1	$ 1,500	$ 1,500
322 -- Fuel supply						
b.	Oil storage tank: To store oil for approximately 5 days' operation	(standard)	15,000 gal. capacity, welded steel tank	1	1,500	1,500
394 -- Miscellaneous						
a.	Hand trucks, auxiliary tables, and other similar equipment	--	--	-	--	5,000
	TOTAL COST OF "OPTIONAL" FACILITIES					$ 8,000

Chapter V

PRODUCTION COSTS FOR A 100-TON PER DAY SWEETPOTATO DEHYDRATION PLANT

Table I -- Summary of Cost of Producing Dehydrated Sweetpotatoes
(Assuming Different Raw Material Costs and Shrinkage Ratios)

Overall-shrinkage ratio of:		4.5 to 1	6 to 1	7 to 1
Output of finished product per day (lbs.)		44,450	33,400	28,580
		Production Cost per Pound of Product		
Processing Cost - See Table II		$0.1434	$0.1685	$0.1854
Assumed cost per 100 tons of Raw Material Entering Processing Line				
At $40 a ton	$4,000 a day	$0.0900	$0.1200	$0.1400
50	5,000	0.1125	0.1500	0.1750
60	6,000	0.1350	0.1800	0.2100
70	7,000	0.1575	0.2100	0.2450
80	8,000	0.1800	0.2400	0.2800
90	9,000	0.2025	0.2700	0.3150
100	10,000	0.2250	0.3000	0.3500
Assumed Production Cost 1/ at Various Costs of Raw Material				
At $40.00 a ton		$0.2334	$0.2885	$0.3254
50.00		0.2559	0.3185	0.3604
60.00		0.2784	0.3485	0.3954
70.00		0.3009	0.3785	0.4304
80.00		0.3234	0.4085	0.4654
90.00		0.3459	0.4385	0.5004
100.00		0.3684	0.4685	0.5354
Estimated Depreciation Charge (See Table X)				
Accelerated write-off		$0.0201	$0.0268	$0.0313
Normal Life Expectancy		0.0093	0.0124	0.0145

1/ Exclusive of Depreciation Charges

Table II -- Processing Cost Summary Using 3 Different Overall Shrinkage Ratios
(Depreciation not included)

	4.5 to 1 (Low)	6 to 1 (Average)	7 to 1 (High)
Input - lbs. per day raw commodity	200,000	200,000	200,000
Output - lbs. per day net yield of sweetpotato dice	44,450	33,400	28,580
Total daily processing cost based upon cost calculation using a 6 to 1 overall shrinkage ratio	$5,628	$5,628	$5,628
Adjustment for Labor -			
Add 1/3 of cost of inspecting, packaging, and shipping labor ($472) for increased output with 4.5 to 1 shrinkage ratio	+ 157		
Deduct 15% of cost of inspecting, packaging, and shipping labor for decreased output with 7 to 1 shrinkage ratio			- 71
Adjustment for Packaging Supplies			
Deduct total packaging supply cost based on 6 to 1 ratio	- 1,788		- 1,788
Add cost applicable to shrinkage ratio (pounds x $0.0535)	+ 2,378		+ 1,529
Adjusted cost 1/	$6,375	$5,628	$5,298
Cost per pound of net product	$0.1434	$0.1685	$0.1854

1/ For purposes of the illustration, it is assumed that all costs per day would be constant for the various yields except the two cost items adjusted. In actual practice, however, costs would be more variable as a result of the different shrinkage ratios.

Table II-A -- Calculation of Unit Costs of Processing for Various Shrinkage Ratios
(Assuming Constancy of cost except as calculated in Table II)

	4.5 to 1		6 to 1		7 to 1	
	Daily Cost	Per Pound	Daily Cost	Per Pound	Daily Cost	Per Pound
Pounds output per day	44,450		33,400		28,580	
Raw material procurement	$ 93	$0.0021	$ 93	$0.0028	$ 93	$0.0033
Direct Labor Cost	2,507	0.0564	2,350	0.0703	2,279	0.0797
Manufacturing Expense	3,295	0.0741	2,705	0.0810	2,446	0.0856
Packaging Supplies and Expenses	2,378	0.0535	1,788	0.0535	1,529	0.0535
Other	917	0.0206	917	0.0275	917	0.0321
General and Administration	480	0.0108	480	0.0144	480	0.0168
Total	$6,375	$0.1434	$5,628	$0.1685	$5,298	$0.1854

Table III -- Processing Cost Summary for Sweetpotato Dehydration Plant

Account No.		Table No. Reference	Processing Cost Per 24-hour Operating Day	Processing Cost Per Pound Dry Product
Output of Finished Product Per Day (6 to 1 overall shrinkage ratio)		II	33,400 pounds	
800 -- Total Cost of Finished Product (exclusive of depreciation and raw material purchase price)			$5,628	$0.1685
100 -- Raw Material Cost (exclusive of purchase price)		IV	$ 93	$0.0028
120	- Buying Expense		63	0.0019
180	- Federal-State Inspection		30	0.0009
200 -- Direct Labor		V	$2,350	$0.0703
210	- Raw Material Handling		145	0.0043
220-230	- Preparing		1,638	0.0491
240	- Drying		95	0.0028
250	- Screening and Inspecting		206	0.0062
260	- Packaging and Packing		202	0.0060
270	- Warehousing and shipping		64	0.0019
300 -- Manufacturing Expense			$2,705	$0.0810
310	- Indirect Labor	VII	205	0.0062
320	- Utilities	VIII	199	0.0060
330	- Maintenance & Repairs	IX	201	0.0060
340	- Depreciation (not included)	I & X	---	------
350	- Taxes and Insurance	XI	142	0.0043
370	- Packaging supplies & Expenses	XII	1,788	0.0535
380	- Inspection & Control	XIII	85	0.0025
390	- Miscellaneous plant Expenses	XIV	85	0.0025
600 -- General & Administrative Expense		XV	$ 480	$0.0144
610	- Office Salaries		219	0.0066
620-690	- Other Expenses		261	0.0078

Table IV -- Raw Material Cost (Account 100)
(Sweetpotato Dehydration Plant)

Account No.			Annual Cost	Cost per Operating Day 1/
100 -- Total Raw Material Cost (excluding purchase price of raw material)			$13,956	$93
110 - Purchase price			------	---
The purchase price of raw material is not included here as a cost. See Table I for calculation of raw material costs at various purchase prices per ton				
120 - Buying Expense			9,456	63
Salary of field agent	$7,000			
Social security, workmen's compensation and unemployment insurance - 6.52%	456			
Expenses - Travel, telephone, etc. (estimated)	2,000			
150 - Transportation and weighing costs (included in Table I as part of assumed prices paid for raw material)			------	---
160 - Storage			------	---
170 - Crate, box, and sack expense			------	---
Depreciation on crates not included. Crates have a life of about 5 years; on this basis, the depreciation charge would be: $144,000/5 = $28,800 a year. The daily cost would be: $28,800/150 = $192. Cost per pound of product would be: $192/33,400 = $0.0057.				
180 - Federal-State Inspection				
One inspector 150 days at $30.00			4,500	30

1/ Assumed to be 150 days a year

Table V -- Direct Labor Cost Summary (Account 200)
(Sweetpotato Dehydration Plant)

Account No.		Per 24-Hour Operating Day: Direct Labor Cost Per Day 1/	Add Labor Expense 20% 2/	Total Direct Labor Cost
200 -- Total Direct Labor Cost		$1,958	$392	$2,350
210	- Raw Material Handling	121	24	145
220-230	- Preparing	1,365	273	1,638
240	- Drying	79	16	95
250	- Screening & Inspecting	172	34	206
260	- Packaging & Packing	168	34	202
270	- Warehousing & Shipping	53	11	64

1/ From Table VI

2/ In addition to tbe "Direct Labor Cost per Day" the following items are additional costs that must be paid by the employer:

	Percentage to apply to calculated labor cost
a. Overtime - All hours per week over 40 are paid for at one-and-one-half times the basic rate. The work week is 48 hours, making 8 hours to be paid at overtime. Thus the employee receives 12 hours pay for 8 hours. For the week he gets 52 hours pay for 48 hours work (52/48) - 1.0 = 0.08333	8.33%
b. Swing and night shift differential may amount to 5¢/hr. This may give an average differential of 2.5% on 3-shift basis	2.50
c. Social Security - Paid by employer	1.50
d. Unemployment Insurance - For a new, highly seasonal business, the rate would be	2.70
e. Workmen's Compensation	2.32
f. Vacation pay - none calculated. A typical union contract provides for vacation with pay after the end of the year in which an employee has worked 1600 hours or more. On a six months' operation, the total would be only 1200 hours	
g. Holiday pay - Practices vary with respect to payment for holidays which occur during work week. Since some union contracts provide for such pay, even when the employee does not work, allowance is made here for such cost	2.67
	20.02%

Table VI -- Direct Labor Cost Work Sheet (Account 200)
(Sweetpotato Dehydration Plant)

Account No.	Operation	Number of Employees per Shift		Hourly Rate of Pay		Total Hours per Shift	Total Cost per Shift	Total Cost per 24-hour Operating Day
		Men	Women	Pay Bracket	Amount			
200 --	TOTAL DIRECT LABOR COST	17	86				$652.80	$1,958.40
210 --	Raw Material Handling	4 1/2	1				$ 40.40	$ 121.20
	Foreman 1/	1/2		1	$1.30	4	5.20	
	Operating lift truck	1		3	1.00	8	8.00	
	Dumping crates	2		4	.90	16	14.40	
	Handling empty crates	1		5	.85	8	6.80	
	Inspecting		1	6	.75	8	6.00	
220-230	Preparing	3 1/2	71				454.80	1,364.40
	Foreman 1/	1/2		1	1.30	4	5.20	
	Floorlady		1	5	.85	8	6.80	
	Operating washer, peeler, etc.	1		3	1.00	8	8.00	
	Trimming		70	6	.75	560	420.00	
	Operating blancher, sulfiting, etc.	1		3	1.00	8	8.00	
	Cleaning up	1		5	.85	8	6.80	
240 --	Drying	3	-				26.40	79.20
241 --	Conveyor drying	1 1/2					13.20	
	Foreman 2/	1/2		1	1.30	4	5.20	
	Operating	1		3	1.00	8	8.00	
248 --	Bin drying	1 1/2					13.20	
	Foreman 2/	1/2		1	1.30	4	5.20	
	Loading, moving, unloading bins	1		3	1.00	8	8.00	
250 --	Screening and Inspecting . . .	3/4	8 1/2				57.40	172.20
	Foreman 3/	1/4		1	1.30	2	2.60	
	Floorlady 4/		1/2	5	.85	4	3.40	
	Inspecting		8	6	.75	64	48.00	
	Cleaning up 5/	1/2		5	.85	4	3.40	
260 --	Packaging and Packing	3	5 1/2				56.00	168.00
	Foreman 3/	1/2		1	1.30	4	5.20	
	Floorlady 4/		1/2	5	.85	4	3.40	
	Feeding cans to filler		1	6	.75	8	6.00	
	Filling cans		1	6	.75	8	6.00	
	Check-weighing cans		2	6	.75	16	12.00	
	Sealing cans & casing		1	6	.75	8	6.00	
	Sealing & branding cases	1		4	.90	8	7.20	
	Stacking cases	1		5	.85	8	6.80	
	Cleaning up 5/	1/2		5	.85	4	3.40	
270 --	Warehousing and Shipping . . .	2 1/4	-				17.80	53.40
	Foreman 3/	1/4		1	1.30	2	2.60	
	Operating lift truck	1		3	1.00	8	8.00	
	Warehousing	1		4	.90	8	7.20	

1/ One foreman for raw material handling & preparing
2/ One foreman for conveyor drying & bin drying
3/ One foreman for screening & inspecting, packaging, and warehousing & shipping
4/ One floorlady for screening & inspecting, and packaging
5/ One cleanup man for screening & inspecting, and packaging

Table VII -- Indirect Labor (Account 310)
(Sweetpotato Dehydration Plant)

Account No.		Number of Employees	Assumed Yearly Rate	Hourly Rate	Total No. of Hours Employed Annually 1/	Yearly Cost	Cost per Operating Day 2/
310 -- Total Indirect Labor						$30,749	$205
	Year-round employees					$25,565	
	Production Supt.	1	$7,000	-	- $7,000		
	Shift Superintendents	2	6,000	-	- 12,000		
	Guards	---3/	-----3/	-	- 5,000		
	Labor Expense - 6.52% 4/				1,565		
	Seasonal employees					$ 5,184	
	Boiler operator and oiler	3		$1.20	3,600 $4,320		
	Labor Expense - 20% 5/				864		

1/ 48 hours per week for 25 operating weeks, a total of 1200 hours for each employee

2/ Yearly cost of $30,749 divided by number of operating days (150)

3/ The estimate of $5,000 for guard service is based upon an assumption of 16 hours of guard service per day for each day of the year. The number of guards actually employed will depend upon how the guard time is divided among the guards. For example, in a week of 7 days, 16 hours a day, or a total of 112 hours, three guards could divide the time so that each would work about 37 hours

4/ Social security 1.50%
Unemployment Insurance 2.70%
Workmen's Compensation 2.32%
6.52%

5/ See Table V for analysis of 20% labor expense

Table VIII -- Utilities (Account 320)
(Sweetpotato Dehydration Plant)

Account No.		Cost per Operating Day
320	-- Total Daily Cost of Utilities	$199
321	- Water supply	---
	500 gallons a minute is estimated need of plant. It is assumed water will be pumped from company's own well, so cost of pumping is included in power cost	
322	- Fuel	145
	Boilers	
	75% load on 600 horsepower boiler	
	$\frac{.75 \times 600 \times 33{,}400 \times 24}{.80 \times 1{,}000}$ = 452,250 cu.ft. of gas	
	Dehumidifier	
	Rated at 950 c.f. per hour	
	950 x 24 = 22,800 cu.ft.	
	Total gas demand 475,050 cu.ft. per day	
	at 30¢ per 1,000 cu.ft. - cost is $145.00	
323	- Electric power	54
	Motors - 310 h.p.	
	(746 watts per h.p. and 75% use and efficiency factor)	
	310 x .746 x .75 . . . . . 173 k.w.	
	Lights (estimated) . . . . . 50 k.w.	
	Tctal electric power . . . . . 223 k.w.	
	Cost per hour at 1 cent per k.w.h. . . . . $ 2.23	
	Cost per 24-hour day $54.00	
325	- Waste Disposal	---
	Garbage disposal - Assumed that solid garbage will be hauled away for feed at no cost to dehydration plant	
	Sewage charges - Assumed disposal in rural area (no cost)	

Table IX -- Maintenance and Repairs (Account 330)
(Sweetpotato Dehydration Plant)

	Total No. of Employees	Hourly Rate Pay Bracket	Hourly Rate Amount	Hours Worked Process Season 1/	Hours Worked Off Season 2/	Total per Employee	Hours for Group	Total Cost per Year
Labor 3/								
Head mechanic	1	1	$1.30	1,200	1,080	2,280	2,280	$2,964
Shift mechanics & oilers	3	2	1.20	1,200	1,080	2,280	6,840	8,208
Maintenance mechanic	1	3	1.00	1,200	1,080	2,280	2,280	2,280
Sub-total	5							$13,452
Add labor expense (13%) 4/								1,748
							Labor Cost	$15,200
Cost of Supplies and Replacements								
Estimated (for entire year)								15,000
Total Cost of "Maintenance and Repairs" for a year								$30,200
Cost per operating day ($30,200/150) $201								

1/ 25 weeks, 150 days, at 8 hours = 1,200 hours

2/ 27 weeks, 5 days a week, 8 hours a day = 1,080 (includes time off for vacations)

3/ Assumed that all mechanics will be employed during off-season on maintenance and repair work

4/ Labor expense during processing season 19.19%

Night shift differential: 2 mechanics out of 5 on night shift. Average hourly rate $1.20 and 5¢ an hour differential (0.05)(2)/(1.20)(5)	1.67%
Social security	1.50
Unemployment insurance	2.70
Workmen's compensation	2.32
Vacation pay (included in time for off-season)	----
Holiday pay (See Table V)	2.67
Overtime - 52 hours pay for 48 hours work (See Table V)	8.33

Labor expense during off-season 6.52%

Social security	1.50%
Unemployment insurance	2.70
Workmen's compensation	2.32
Vacation and holiday pay included in regular 40-hour week . . .	----

Calculation of labor expense percentage to apply:

(1,200 hours with 19.19%) 1,200 x .1919 = 230.28

(1,080 hours with 6.52%) 1,080 x 0.0652 = 70.42

300.70 300.70/2,280 = 13.19%

Table X -- Depreciation (Account 340)
(Sweetpotato Dehydration Plant)

Depreciation is not included as a cost because of the uncertainty of the write-off period that may be allowed. (See "Business Consideration" in Volume I.) The depreciation charges that would be incurred in this plant are calculated below for two possible write-off periods.

1. Assuming normal life expectancy and probable useful lives (as given in Bulletin F, U.S. Treasury Dept., Bureau of Internal Revenue)

Property Item	Original Cost 1/	Estimated 10% Salvage Value	Cost to be Depreciated	Useful Life (years)	Annual Depreciation Charge
Building & Grounds 2/	$210,000	$21,000	$189,000	50	$ 3,780
Crates	144,000	none	144,000	5	28,800
Equipment	493,405	49,340	444,065	15	29,605
Total	$847,405	$70,340	$777,065	--	$62,185

Depreciation Charges:

Per operating day ($62,185/150)	$ 415
Per lb. of product at 4.5:1 ($415/44,450)	$0.0093
Per lb. of product at 6:1 ($415/33,400)	0.0124
Per lb. of product at 7:1 ($415/28,580)	0.0145

2. Assuming 5 year write-off of 75% of capital investment

Total capital investment	$ 847,405
Less crate cost	144,000
	$ 703,405
75% to be written off	$ 527,550
Annual charge ($527,550/5)	$ 105,510
Add depreciation on crates	28,800
Total depreciation charge	$ 134,310

Depreciation charges:

Per operating day ($134,310/150	$ 895
Per lb. of product at 4.5:1 ($895/44,450)	$0.0201
Per lb. of product at 6:1 ($895/33,400)	0.0268
Per lb. of product at 7:1 ($895/28,580)	0.0313

1/ Includes Engineering Construction fees (Building & Grounds $5,000; Equipment $25,000)
2/ Includes value of land

Table XI -- Taxes and Insurance (Account 350)
(Sweetpotato Dehydration Plant)

Account No.		Cost per Operating Day
350 -- Taxes and Insurance Expense		$142
For purposes of this estimate, taxes and insurance on property are combined.		
Estimated cost of facilities	$850,000	
Taxes and insurance at 2 1/2%	21,250	
Cost per operating day ($21,250/150)		$142

Table XII -- Packing Supplies and Expenses (Account 370)
(Sweetpotato Dehydration Plant)

Account No.		Cost per Operating Day
370 -- Total Packing Supplies and Expenses		$1,788
Cans		
Allowing 3 pounds of dehydrated sweetpotatoes per No. 10 can		
33,400/3 = 11,133 cans per day at $99 per M		$1,102
Cases		
1,856 per day (6 cans per case) at $299.25 per M		556
Supplies		
Straps, glue, recipe sheets, etc. at 1¢ a can		112
Allowance for Losses (1% of $1,770)		18

Table XIII -- Inspection and Control (Account 380)
(Sweetpotato Dehydration Plant)

Account No.			Annual Cost	Cost/Operating Day
380 -- Total Cost, Inspection & Control			$12,711	$85
Salaried Employees:				
Quality Control Technologist		$6,000		
Labor expense (6.52%)		391	6,391	
Hourly Employees:				
3 laboratory technicians at $1.00/hr. (3,600 hrs)		$3,600		
Labor expense (20%)		720	4,320	
Supplies & Other Miscellaneous Expenses			2,000	

Table XIV -- Miscellaneous Plant Expenses & Income (Account 390)

Account No.	Cost/Operating Day
390 -- Miscellaneous Plant Expenses	$85
391 - Lunch room operation - Assumed that sales of meals would offset the lunch room expense	
392 - Chemicals - Sulfiting materials, etc. (estimated)	$10
393 - Sale of trimmings, fines, etc. The flowsheet indicates that about 250 pounds an hour of "fines" and "rejects" will be removed from the dried product. This would amount to about 2.5 tons a day. This cost estimate does not assume any return from the sale of such material, although some return might be obtained	---
394 - Other miscellaneous costs (estimated)	75

Table XV -- General and Administrative Expenses (Account 600)

Account No.	Cost/Operating Day
Estimated at 4% of production cost (of approximately 36¢/lb.) . . . . . (33,400 x 36¢ x 4% = $480)	$480

Annual cost (480 x 150) = ... $72,000

This estimate is consistent with World War II experience when dehydrators reported General and Administrative Expense ranging from 1% to 15% of total production cost, and averaging between 4% and 5%. This annual cost might be made up as follows:

610 - Salaries:	General manager	$10,000		
	Office manager	6,000		
	Personnel officer	4,800		
	Clerks (4 at $2,500)	10,000	$30,800	
	Labor expense (6.52%)		2,000	$32,800
620-690 - Other expenses				39,200

CHAPTER VI

SUMMARY OF CAPITAL AND CREDIT REQUIREMENTS

Fixed Capital and Credit Requirements:			
Plant Equipment		$612,400	
Buildings and Grounds		205,000	
Construction Engineering Fees		30,000	
6-Month General Expense: (From "Production Costs")			
From Table IV - Raw Material Procurement . .	$4,750		
From Table XIII - Inspection & Control . .	6,350		
From Table XV - General Administration	36,000	47,100	894,500
Operating Capital and Credit Requirements:			
75-day Operating Costs ($12,000/ operating day) 1/		$900,000	
75-day Supply of Raw Sweetpotatoes ($6,000/ operating day) 2/.		450,000	
25-day Inventory of Manufacturing Supplies (exclusive of raw commodity) ($1,788/ operating day)		44,600	1,394,600
			$ 2,289,100
General Contingency Fund:			
Equivalent to approximately 10% of Estimated Capital Requirements			230,000
ESTIMATED TOTAL CAPITAL AND CREDIT REQUIREMENTS			$ 2,519,100

1/ Based on 33,400 lbs. dehydrated sweetpotatoes (diced) per day at an approximate cost of 36¢/ lb.

2/ The entire season's need (6 months) for raw sweetpotatoes may have to be paid for in a relatively short period and prior to receiving any payment from the purchaser of finished product. A part of these costs may be in the form of advance payments to growers for seed, fertilizer, insecticide, labor, etc. This capital requirement is based on an assumed cost of raw product of $60/ton (total cost delivered to plant).

FIG. 1 USUAL PLANTING AND HARVESTING PERIODS FOR SWEETPOTATOES IN PRINCIPAL PRODUCING STATES

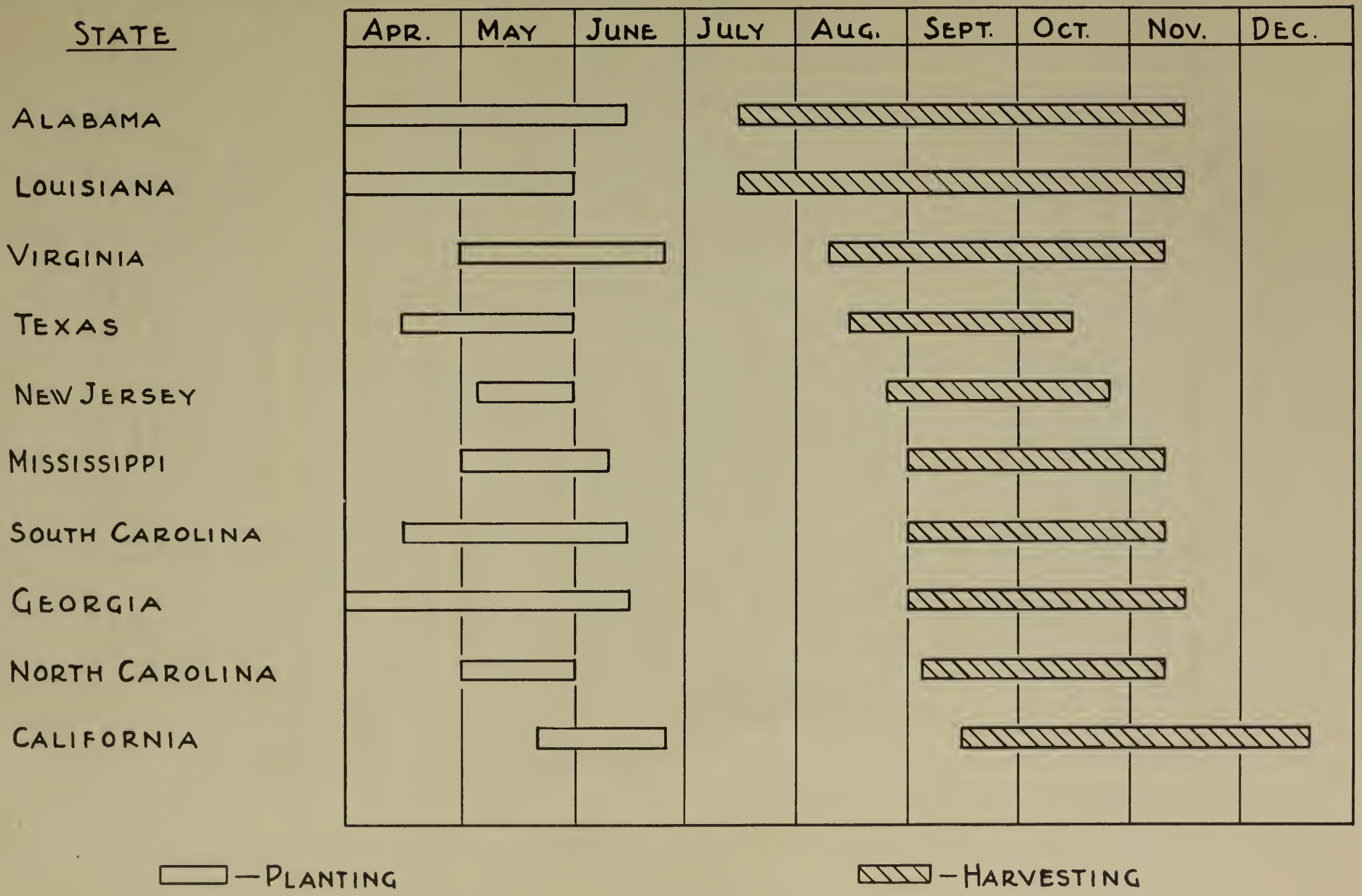
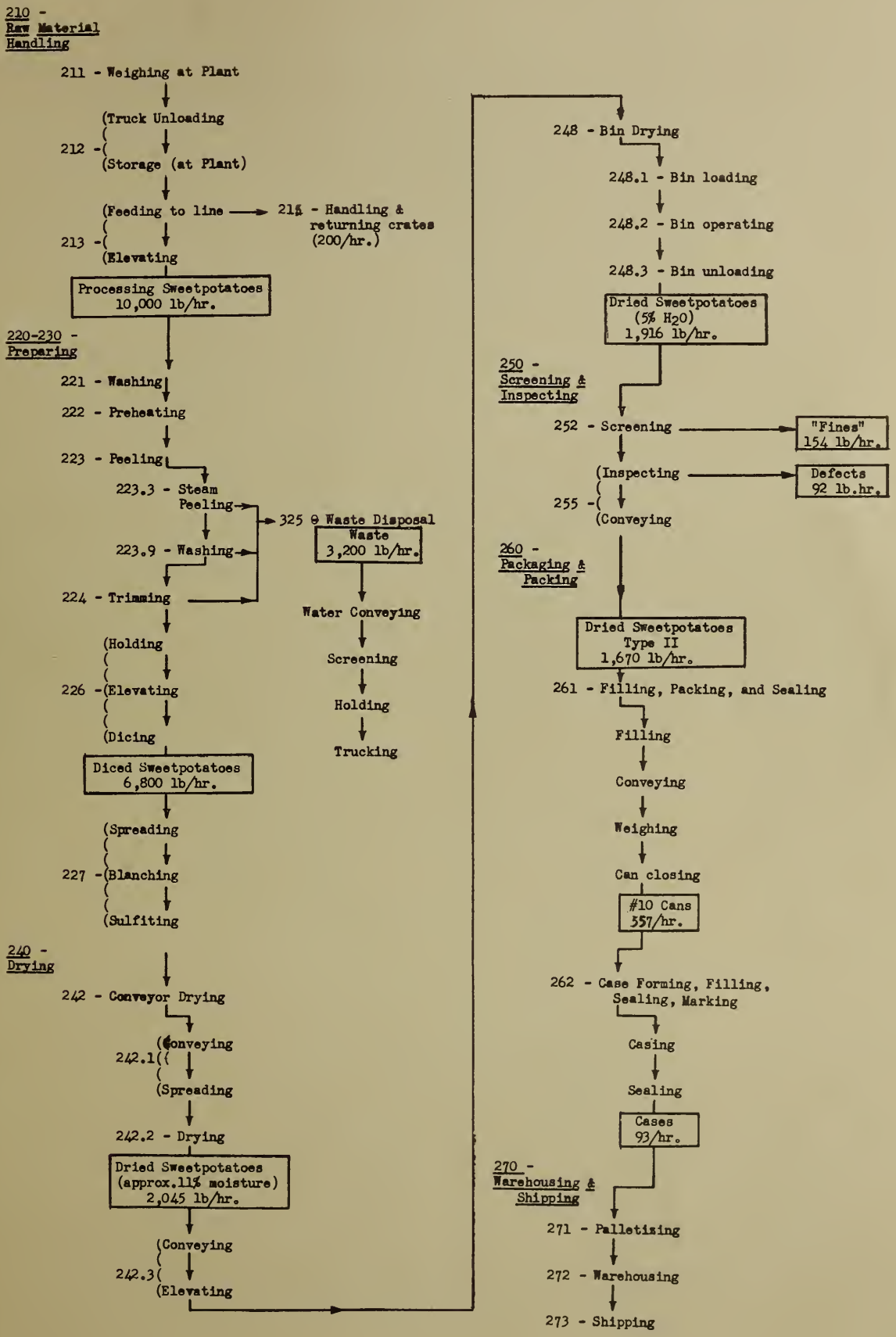


Figure 2

FLOW SHEET FOR SWEETPOTATO DEHYDRATION

Capacity 100 Raw Tons Per Day



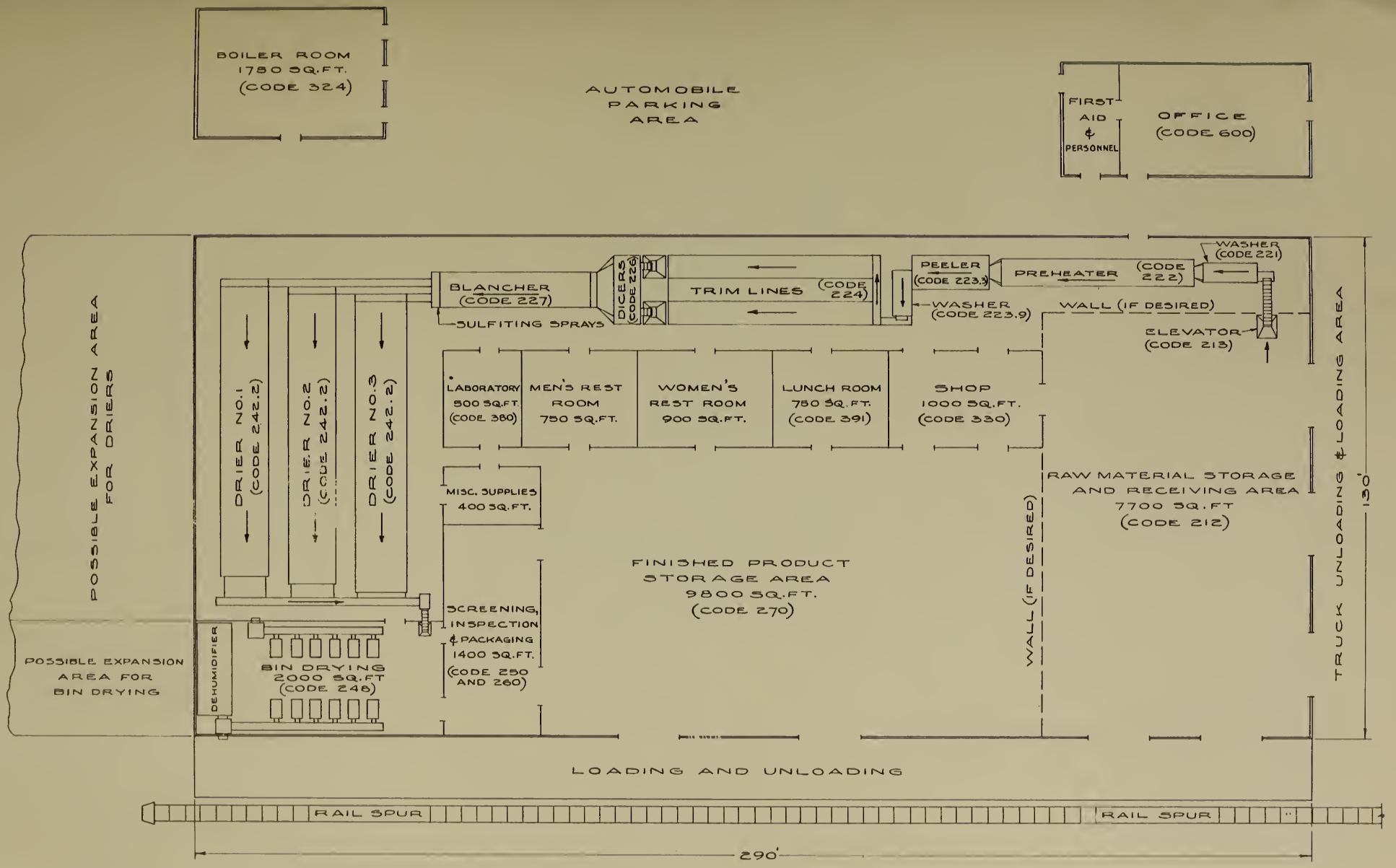
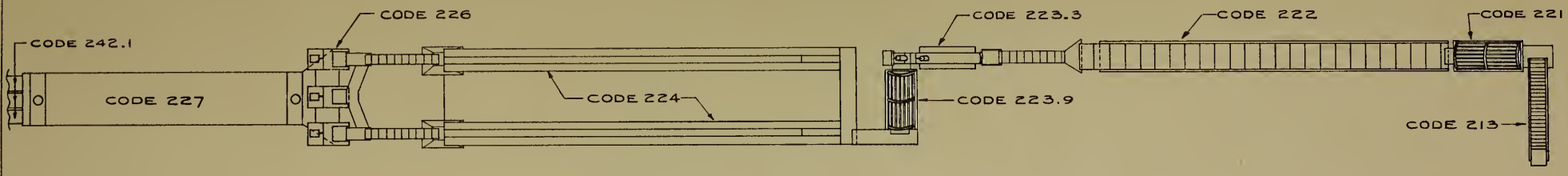


FIGURE 3

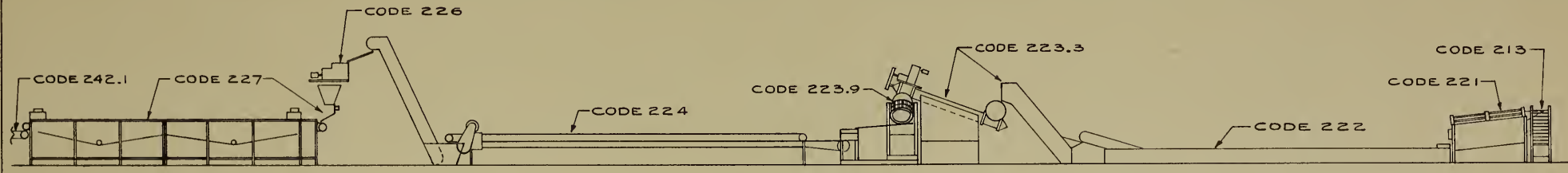
PROPOSED FLOOR PLAN FOR SWEETPOTATO DEHYDRATION PLANT

AREA APPROXIMATELY 41,000 SQ.FT.

0 5 10 15 20 FT.



PLAN



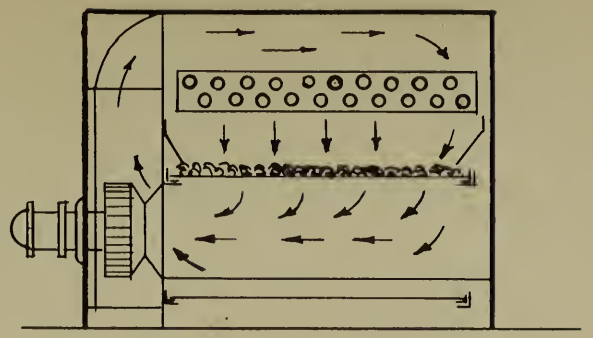
ELEVATION

LEGEND

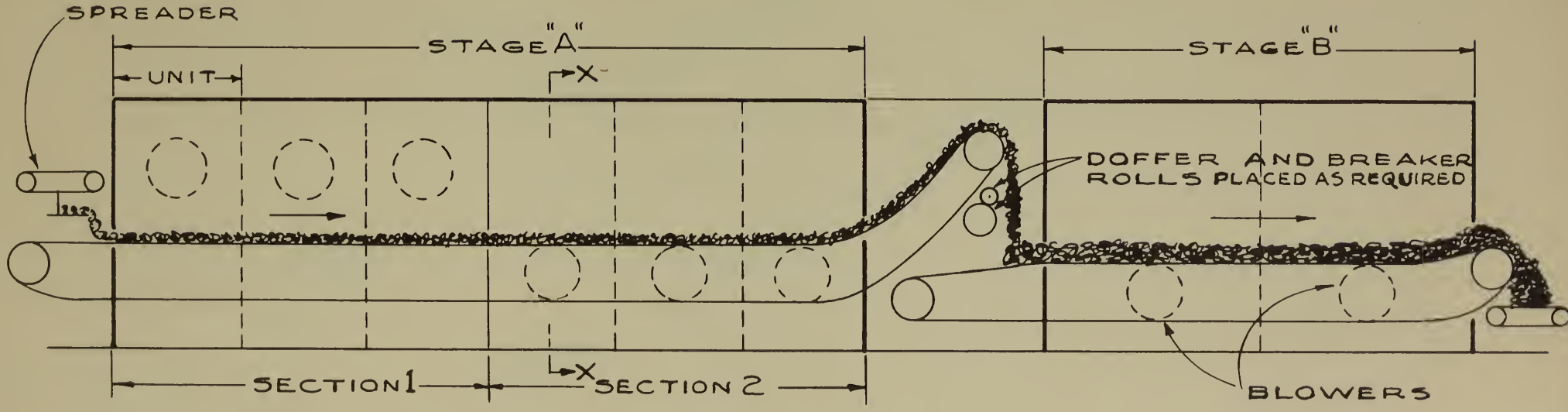
CODE	213	ELEVATOR
	221	WASHER
	222	PREHEATER
	223.3	STEAM PEELER
	223.9	WASHER
	224	TRIMMING TABLE
	226	DICERS
	227	BLANCHER & SPREADER
	242.1	CONVEYORS

FIGURE 4

PREPARATION LINE FOR SWEETPOTATO DEHYDRATION



CROSS-SECTION THROUGH UNIT "XX"



ELEVATION

FIGURE 5

SKETCH OF TYPICAL CONVEYOR DEHYDRATOR

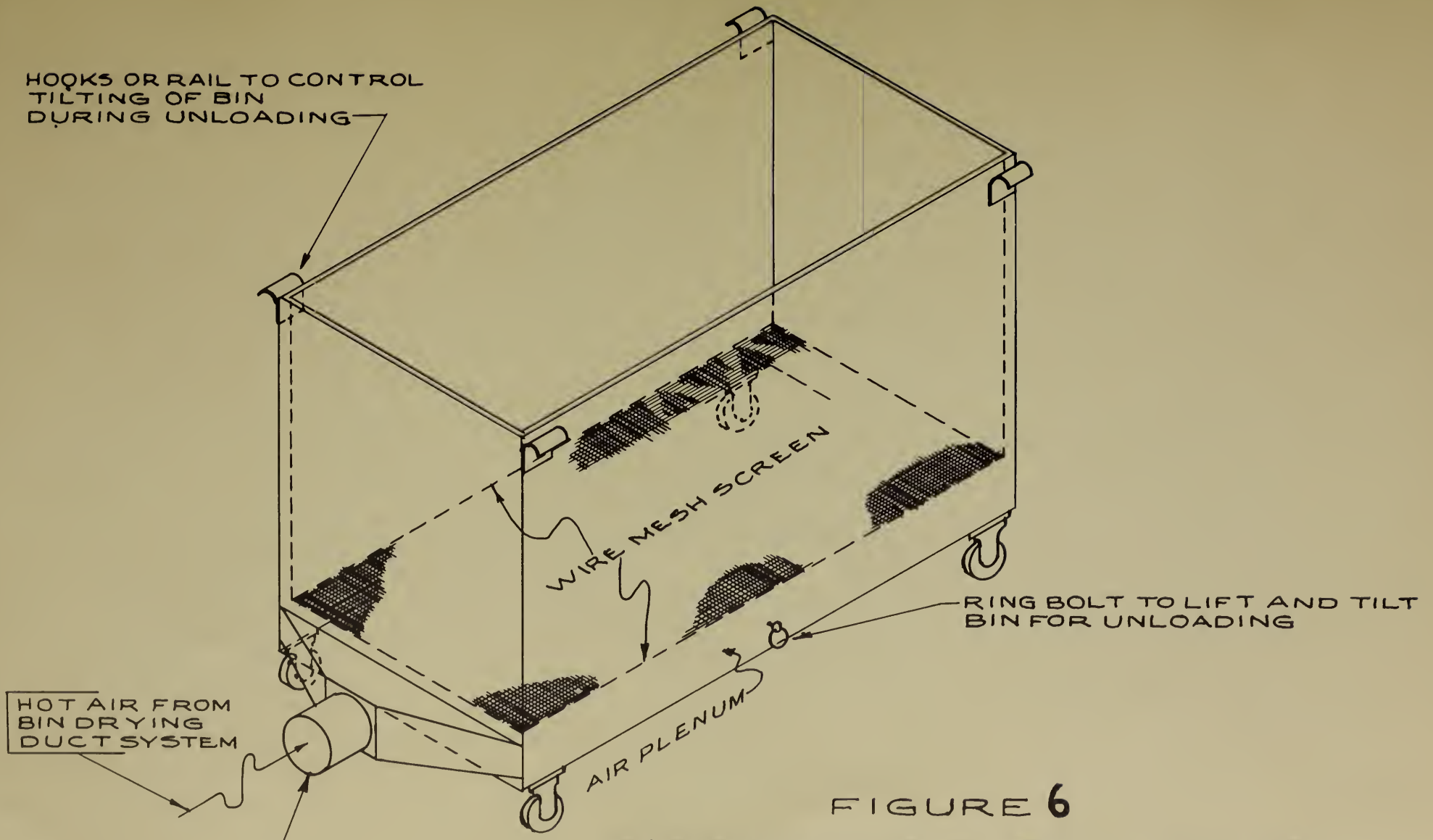


FIGURE 6

DIAGRAMMATIC SKETCH OF PORTABLE BIN FINISHER

(CODE 248.1)

GPO 86-093129